NAVAL POSTGRADUATE SCHOOL

CS 4203 USABILITY ANALYSIS
CAPTURE THE FLAG

by

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Introduction

Needs Analysis

Capture the Flag, a networked simulation, is the product of several group projects from CS4202 Computer Graphics, CS4472 Physically Based Modeling, CS4474 Virtual Environment Network and Software Architectures. The game evolved from a basic flight model of a helicopter, to a networked helicopter simulation, to a combat simulation including tanks, terrain, and hit detection. As a result, students are able to explore and demonstrate computer graphics and network technologies.

User Analysis

- College-aged student.
- Interest in games and networked simulations.
- Basic computer skills (familiar with windows point and click paradigm).
- Relaxed, learn at own-pace environment.

Task Analysis

The simulation is based on Virtual Reality Modeling Language (VRML); a dynamic 3D-scene description language that can include embedded behaviors and camera animation. A rich set of graphic primitives provides a common-denominator file format that can be used to describe a wide variety of 3D scenes and objects. Figures 1a and1b demonstrate a simple VRML scene. VRML is available from several vendors as plug-ins for Netscape or Internet Explorer.

VRML is combined with Java to provide a standardized, portable and platform independent way to render dynamic, interactive 3D scenes across the Internet. Java adds complete programming capabilities plus network access, making VRML fully functional and portable.

Figure 1a. VRML scene.

Figure 1b. VRML scene rotated.

Application Description

Capture the Flag runs in a VRML window as shown in Figure 2.

Figure 2. VRML Browser displaying Capture the Flag.

The view perspective can be manipulated using the mouse and the center control console of the VRML browser to rotate, pan, and zoom the viewpoint. Several standard views are available from the pop-up menu button on the left side as demonstrated in Figure 3.

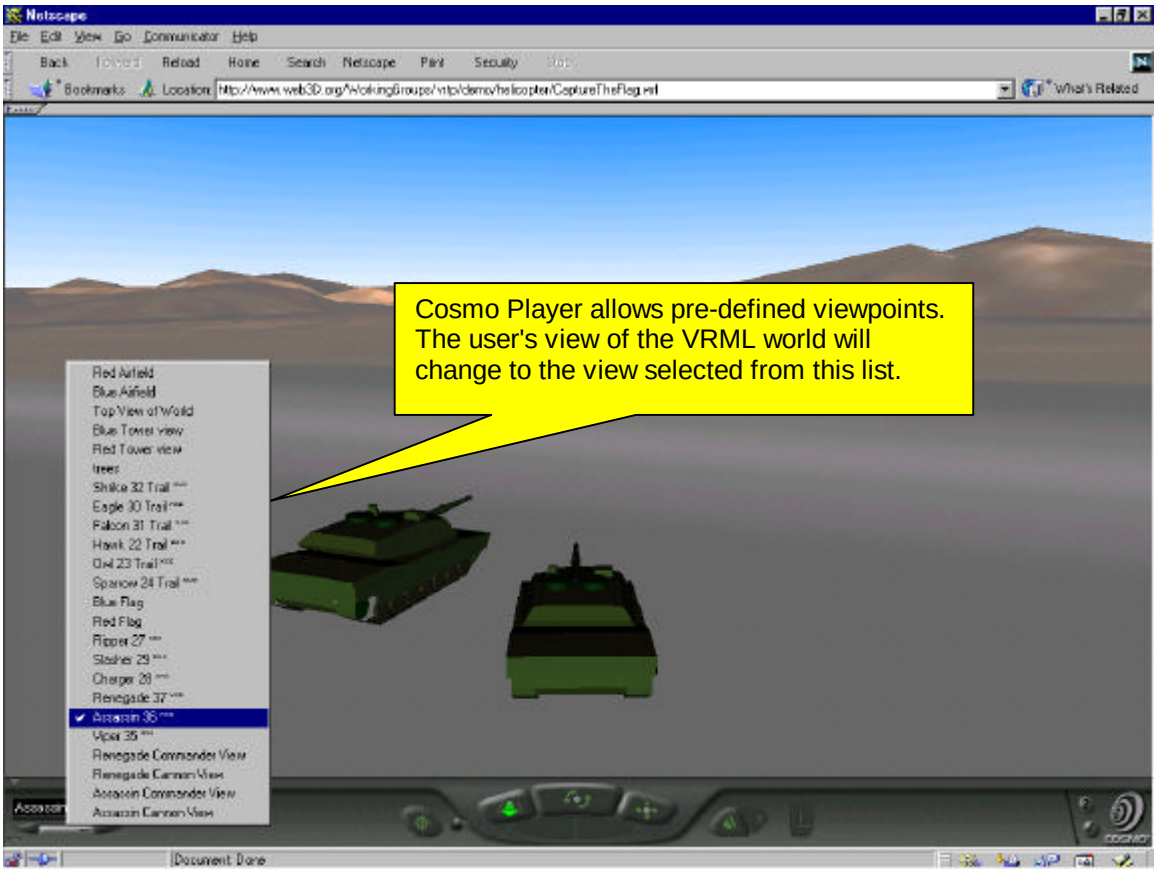


Figure 3. Viewpoint selection in VRML browser.

The vehicles are control through a Java based interface. The user selects a team as shown in Figure 4.

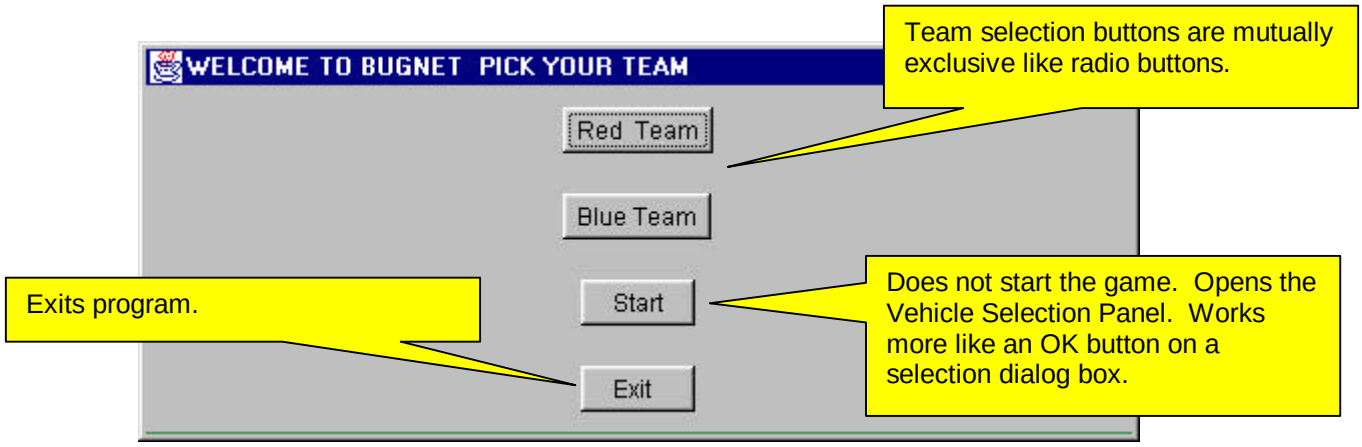


Figure 4. Team selection.

The user then selects a vehicle (six tanks and six helicopters available). Address and port number are assigned by the program and do not require modification.

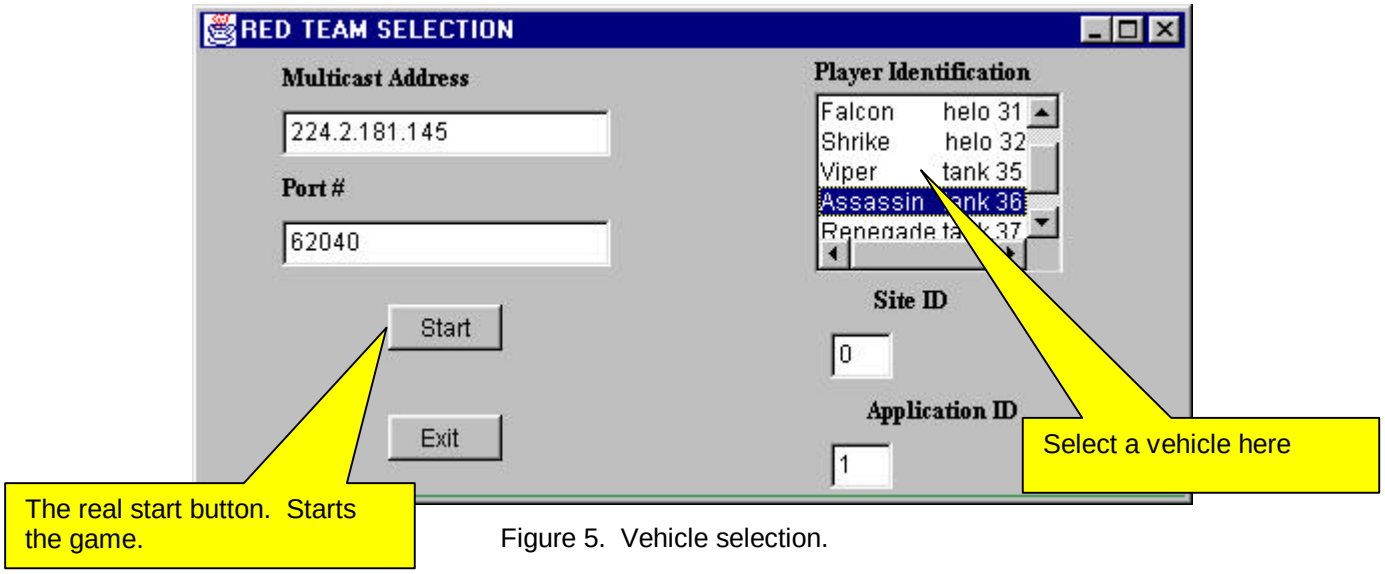


Figure 5. Vehicle selection.

The tank and helicopter control panels shown in Figure 6a and 6b allow the user to interact with his vehicle by using the mouse to click on the desired action. Visual feedback is provided through the user's Netscape VRML browser.

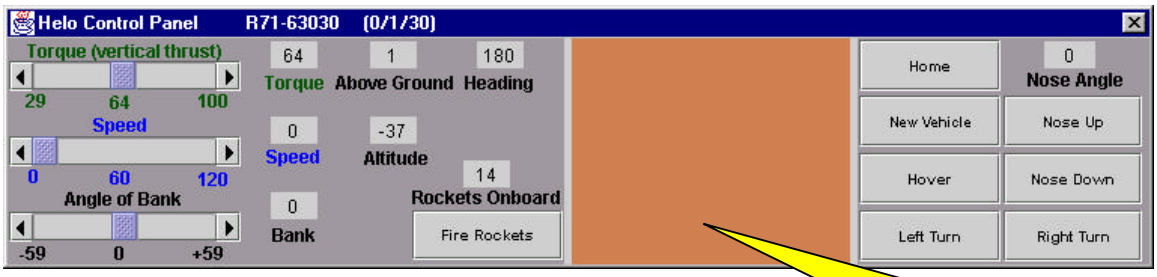


Figure 6a. Helo control panel.

Blank panel. Does nothing.

Helo Control Panel Components

Component	Purpose
Torque slider	Increase/decrease altitude
Torque text field	Current torque value (uneditable)
Speed slider	Increase/decrease forward speed
Speed text field	Current speed value (uneditable)
Angle of Bank slider	Used for turning
Bank text field	Current bank angle (uneditable)
Above Ground text field	Height above the surface of the Earth (uneditable)
Altitude text field	Height above sea level (uneditable)
Heading text field	Direction vehicle is facing
Rockets Onboard text field	Number of rockets remaining
Fire Rockets button	Fires a rocket
Home button	Returns vehicle to it original start position
New button	Destroys current vehicle and opens Team Selection Panel
Hover	Immediately puts helicopter in a level hover above the ground
Left/Right Turn buttons	Starts helicopter turning. Must be pressed again to stop turning.
Nose Up/Down buttons	Raises/Lowers the nose of the helicopter.

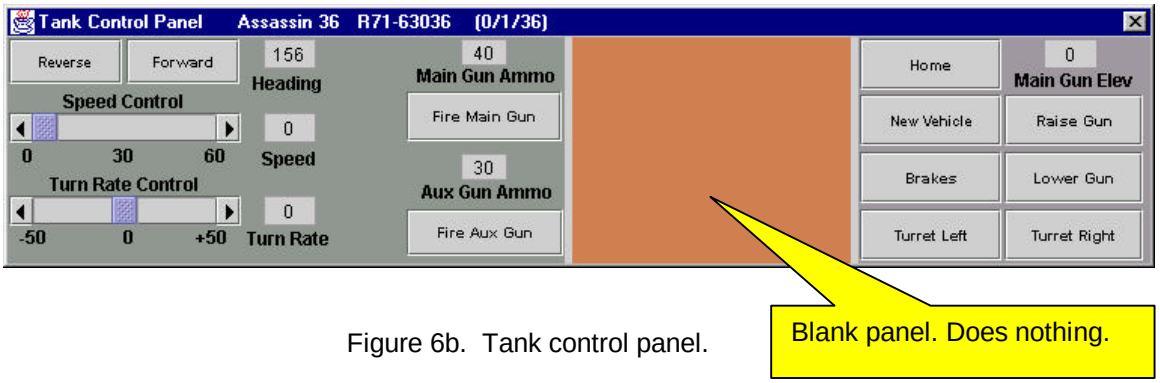


Figure 6b. Tank control panel.

Tank Control Panel Components

Component	Purpose
Reverse/Forward buttons	Gear selection (mutually exclusive)
Heading text field	Direction vehicle is facing (uneditable)
Speed Control slider	Increase/decrease speed
Speed text field	Current speed value (uneditable)
Turn Rate Control slider	Used for turning
Turn Rate text field	Current rate of turn (uneditable)
Main Gun Ammo text field	Number of main gun rounds remaining
Fire Main button	Fires the main gun
Aux Gun Ammo text field	Number of auxiliary weapon rounds remaining
Fire Aux Gun button	Fires the auxiliary gun
Home button	Returns vehicle to it original start position
New button	Destroys current vehicle and opens Team Selection Panel
Brakes button	Immediately halts tank
Turret Left/Right buttons	Begins rotating the turret. Must be pressed again in order to stop the rotation.
Main Gun Elev text field	Indicates the angle of elevation for the main gun
Raise/Lower Gun buttons	Begins raising/lowering main gun. Must be pressed again in order to stop raising or lowering the gun.

The user's screen is usually arranged as shown in Figure 7. The VRML window occupies the upper 2/3 of the screen with the GUI control panel and the command-line window occupying the bottom 1/3, but this may be modified by the user.

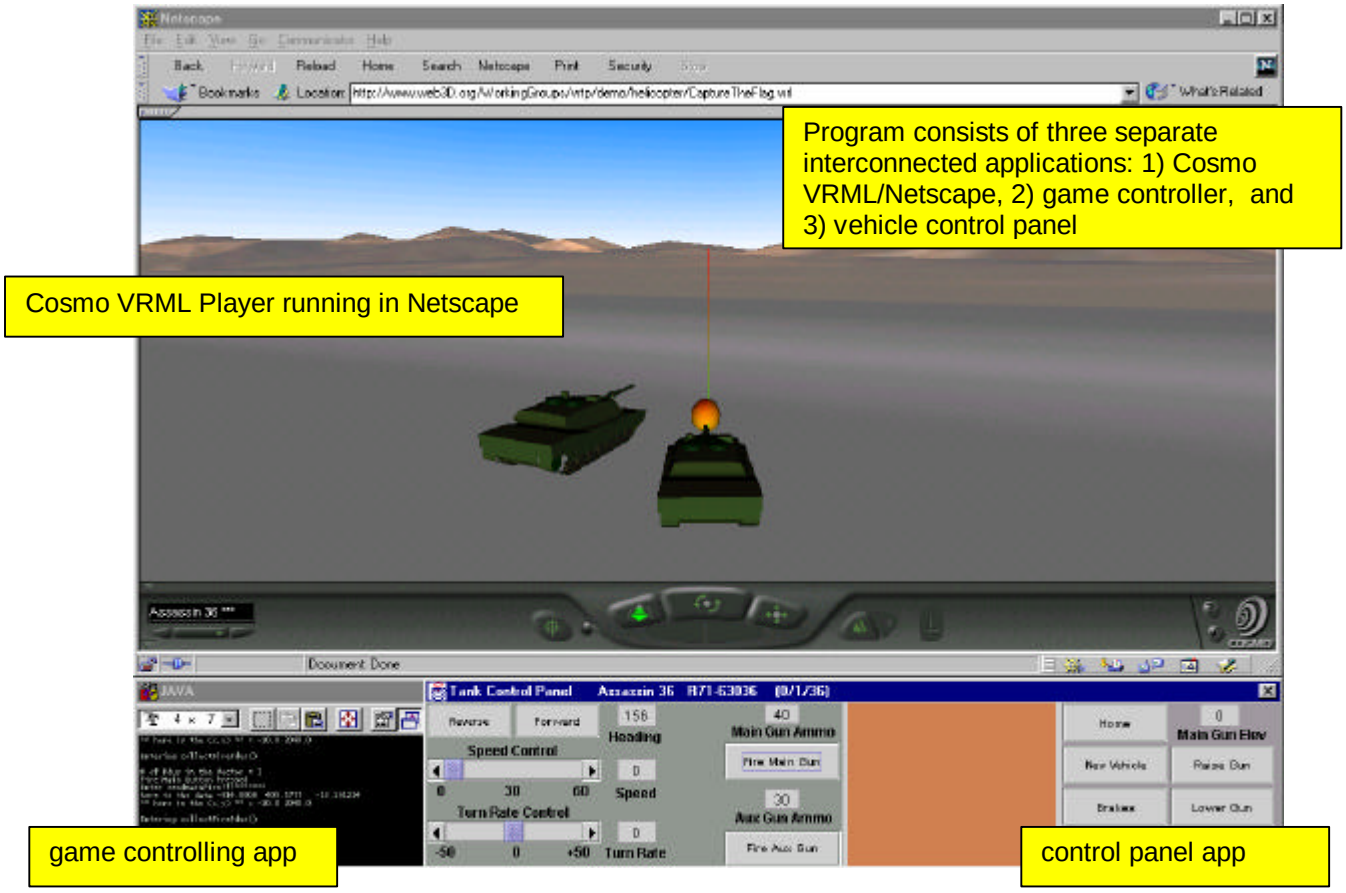


Figure 7. Full user display with tank firing.

The goal of the game is to navigate individually or as a team from the user's home airfield to the opponent's airfield, capture the flag, and return to the user's home airfield without being killed. Each successful retrieval of an opponent's flag scores a point for the capturing team. The game ends after a pre-designated number of points are scored.

Problem Definition

Study Objective

The objective of this study is to evaluate the effectiveness of the user interface of the Capture the Flag application and to recommend alternatives for improving human computer interaction in future versions of the application. The study will evaluate the entire interface, as opposed to limiting its scope to vehicle control panels or graphical displays. The entire interface includes the control panels, the console windows, input devices, and the virtual reality graphical display. The study will also include the system's computing platform, since this is a game that is heavily dependent upon audio and visual sensory output to the user. The study will also include the environment, in which the game is played. The game is intended to be played in teams, where the opposing teams and even players on the same team may be geographically separated or co-located. We feel that the environment may play a role in the user interface's effectiveness.

Results

The results will be recommendations for improving the user interface, which will be based upon conclusions drawn from both quantitative and qualitative data obtained from experimentation and observation of users who have used or are using the system as participants in our study.

Purpose for Conducting the Study

We wish to practice the current concepts and theories of the human-computer interface (HCI) field of computer science. The study will help us to understand and describe the human factors relevant to designing good human-computer interfaces. We will gain first-hand experience in an iterative system development process, which will provide us with some insight to the relationship between human error and poor design, as well as, how to prevent both problems. By studying the data and recommending approaches, we will gain an appreciation for selecting appropriate interaction devices and techniques from alternative solutions.

What Questions Are We Trying to Answer

We will try to answer the following questions:

- Do the control panels make sense? Do users understand what each control on the panel does and how it affects the vehicle's behavior? What metaphors are appropriate and what can be added, removed, or modified to make the panels better?
- Are the input devices appropriate for the activity? If not, what are some better alternatives?

- Is the environment or setting that the game is played in conducive to the activity? What would be a more suitable environment? Does the environment enable the user to feel as if he or she is on a team? How does the environment assist the user in interacting with teammates?
- How well does the VRML world reflect the battlefield situation to the user? Does the user feel immersed in an interactive virtual environment, or does the user feel detached from the situation and only peripherally involved? Should the user feel as he or she is virtually in the simulated environment? How can the interface be more conducive to immersing the user into the game's virtual simulated environment?
- If total immersion is the goal, how can it be most achieved given development constraints, which include budget and technology? How can it be achieved given no budgetary constraints?
- How well do the control panels interact with the VRML world? Do the activities in the VRML world, which are triggered by the user interacting with the control panel, coincide with the user's expectations? For example, is the user satisfied with the reaction of the VRML world when he or she presses the "fire rocket" button on the control panel? Is the timing between the pushing of the button and the firing of the rocket make sense to the user? What does the user expect to see and hear when the "fire rocket" button is pushed? What does the user expect to see and hear when he or she pushes the "right turn" button on the control panel?
- Are the speed and maneuverability of the vehicles in line with what the user expects? What does the user expect in terms of maneuverability? Given the user profile, is it too difficult or too easy to fly a helicopter or a tank? How can maneuverability be brought into line with user expectations?
- Do the rules of the game make sense to the user? How quickly does the user understand the rules?
- How easy is it for the user to start a game from the start panel? Does the start panel interface make sense to the user? Does the user understand what the buttons on the panel mean? Does the vehicle selection box and multicast IP address text input box confuse the user? How can the interface be improved to make starting a game easier?
- Is the user satisfied with the game? Is it challenging enough? Is it too easy or too difficult? Is the game boring? What would make the game more interesting for the user? Would the user want to play the game again? What would make the user want to play the game again?
- How well does the VRML world represent the terrain to the user? Do the mountains look like mountains? Can the user recognize other vehicles and identify terrain features and landmarks? How well does the terrain render objects? Is it fast enough for the user? Is the VRML user interface confusing and too difficult to use? Does the VRML world give the user

all of the functionality and views that the user expects or desires? How can the VRML interface be improved?

Approach to the Study

Type of Study

We will conduct a formative analysis of the human-computer interface. The study will be informal. We feel that this type of study is appropriate given the limited time of the study and the fact that the application is an already existing, functioning application that is constantly being developed.

Usability Specifications

We will develop usability specifications for our project, which will include the attributes that will help us answer the questions above. The attributes that we will use include initial performance, first impression, and learnability. We will be unable to measure the following attributes due to time constraints: long-term performance, retainability, advanced feature usage, and long-term user satisfaction. We feel that initial performance, first impression, and learnability are attributes that are appropriate measurable attributes, for which, realistic representative tasks can be developed, tested, and analyzed. We will develop tasks as benchmarks for gathering objective, quantitative data for analysis. Usability attributes, benchmarks, and results will be recorded in a usability specification table as described in Developing User Interfaces: Ensuring Usability through Product & Process by Deborah Hix and H. Rex Hartson.

Tasks

As stated above, we will develop a task list that will serve as benchmarks for obtaining objective, quantifiable results. The tasks will be realistic and representative for all users that meet our user profile. The task list will state clearly what the participant is to attempt to accomplish, what we expect the results to be, and how we will measure the outcome.

Data Collection

We will collect data by asking volunteers that are representative of a typical user of the application to agree to participate in a usability study. The participants will be instructed to accomplish the tasks from the task list. We will observe and record their performance and behavior while conducting the tasks. We may also ask the user to complete a post-task questionnaire for subjective and qualitative input as to how they feel about the user interface. For post-task data collection, we intend to use the methodology used by Dylan Schmorrow in his thesis, "A Benchmark Usability Study of the Tactical Decision Making under Stress Decision Support System."

Data Analysis

Data will be collected during the experiment and recorded in the usability specification table, and data may be collected from post-task questionnaires. We will develop the specific mechanics for data collection prior to the experiment by running one or two participants through a pilot test one week before the experiment. The data must be quantifiable, so that charts and graphs can be produced for analysis. Schmorrow's technique for collecting and tabulating qualitative input will enable the group to analyze data collected from a post-task questionnaire. Data analysis will focus on determining problem areas concerning the human-computer interface.

Problem Resolution

For every problem area, we will recommend a possible solution for future development of the application. We will form our recommendations from the data collected during the experiment. We will neither modify the application's code nor test alternative hardware. Our recommendations will be based solely on our analysis of the data collected during the experiment.

Methodology

Design of the Study

The objective of this study is to evaluate the effectiveness of the user interface of the Capture the Flag application and to recommend alternatives for improving human computer interaction in future versions of the application. The study will evaluate the entire interface, as opposed to limiting its scope to vehicle control panels or graphical displays.

We will conduct a formative analysis of the human-computer interface. We feel that this type of study is appropriate given the limited time of the study and the fact that the application is an already existing, functioning application that is constantly being developed.

Formative analysis is the evaluation of the interaction design as it is being developed, early and continually throughout the interface development process. This is in comparison to summative evaluation, which is evaluation of the interaction design after it is complete. Summative evaluation is often used during field or beta testing, or to compare one product to another.

Formative evaluation produces quantitative data against which developers can compare the established usability specifications. It also produces qualitative data that can be used to help determine what changes to make to the interaction design to improve its usability. The formative evaluation should begin as early in the development cycle as possible, in order to discover usability problems while there is still plenty of time for modifications to be made to the design. By waiting until late in the development process, much of the interface will already be implemented, and it will be far more difficult to make changes indicated by usability study.

The major steps of the formative evaluation will include the following:

- Developing the experiment
- Directing the evaluation sessions
- Collecting the data
- Analyzing the data
- Drawing conclusions to form a resolution for each problem
- Redesigning and implementing the revised interface

Developing the Experiment

Developing an experiment to be used for formative evaluation involves four main activities:

- Selecting participants (subjects) to perform tasks
- Developing tasks for participants to perform
- Determining protocol and procedures for the evaluation sessions
- Pilot testing to shake down the experiment

Usability Specifications

We will develop usability specifications for our project, which will include the attributes that will help us analyze the usability of the interface. The attributes that we will use include *initial performance, first impression,* and *learnability*. We will be unable to measure the following attributes due to time constraints: long-term performance, retainability, advanced feature usage, and long-term user satisfaction. We feel that initial performance, first impression, and learnability are attributes that are appropriate measurable attributes, for which, realistic representative tasks can be developed, tested, and analyzed. We will develop tasks as benchmarks for gathering objective, quantitative data for analysis. Usability attributes, benchmarks, and results will be recorded in a usability specification table.

Developing the Tasks

As stated above, we will develop a task list that will serve as benchmarks for obtaining objective, quantifiable results. The tasks will be realistic and representative for all users that meet our user profile. The task list will state clearly what the participant is to attempt to accomplish, what we expect the results to be, and how we will measure the outcome.

Collecting the Data

We will collect data by asking volunteers that are representative of a typical user of the application to agree to participate in a usability study. The participants will be instructed to accomplish the tasks from the task list. We will observe and record their performance and behavior while conducting the tasks. We may also ask the user to complete a post-task questionnaire for subjective and qualitative input as to how they feel about the user interface

Analyzing the Data

Data will be collected during the experiment and recorded in the usability specification table, and data may be collected from post-task questionnaires. We will develop the specific mechanics for data collection prior to the experiment by running one or two participants through a pilot test one week before the experiment. The data must be quantifiable, so that charts and graphs can be produced for analysis. Data analysis will focus on determining problem areas concerning the human-computer interface.

Problem Resolution

For every problem area, we will recommend a possible solution for future development of the application. We will form our recommendations from the data collected during the experiment. Our recommendations will be based solely on our analysis of the data collected during the experiment.

Setting the Benchmarks

Benchmark tasks provide quantitative and objective metrics that are the foundations of usability specifications. “Time to complete a task” and “Number of errors during the performance” are the objective values that we will measure during the experiments. The values in *worst acceptable level, planned target level,* and *best possible level* columns will determine what user performance will be acceptable, both to the users and to the developers of the system.

Worst Acceptable Level

The worst acceptable level is the lowest acceptable level of user performance for each usability attribute, not the worst that can happen. This border of failure for usability is the boundary between an acceptable and an unacceptable system for each specific attribute.

Planned Target Level

The planned target level is the target value indicating attainment of unquestioned usability success for the present version of the interface; it is the “what you would like“ level. It is the nominal usability goal for each specific attribute.

Best Possible Level

The best possible level is a realistic state-of-the-art upper limit, the inspiration level of a usability attribute. The best possible level shows both management and developers the potential for an attribute and serves as a target for future versions of the interface.

Observed Results

The observed results are the actual values obtained from observing users performing the prescribed tasks during formative evaluation sessions. This column provides such a useful way to do quick comparisons between the specified levels and the actual results of user testing.

Our benchmark values will be based upon the performance of the team members while using the system. Obviously, these values will be “best guesses”, but it is far worse to attempt to develop a user interaction design without any usability specification than to develop one while measuring against best guesses.

Subject Selection and Number of Subjects

The decision on who should participate in the usability study should be based on developed user profiles. However, time and budget constraints force us to select our participants from our school, Naval Postgraduate School. In fact, the user profile for Capture the Flag is quite similar to the profile of the subjects participating in the study.

The decision on how many subjects are required for the study is based upon the usability analysis requirements and the constraining factors. The realities of time and budget constraints result in usability studies having ten to twenty subjects. We decided that twelve participants is enough to complete the study as efficiently as possible. These participants will be military officer students who are studying Master of Science at NPS.

The user profile for Capture the Flag requires that users be familiar with mouse and have some basic computer skills. Since our subjects will be MS students, they easily fulfill these user qualifications.

Task List

See the Participant’s Task List, Evaluator’s Task List, and Usability Specification provided in the appendices.

Data

There are two types of data that will be collected during the tests:

Quantitative Data

These are numeric data and results, such as user performance metrics or opinion ratings. The quantitative data will be used to produce charts and graphs for the analysis. This kind of data will be collected during the experiment and recorded in the usability specification table. Also, post-task questionnaires will provide quantitative data.

Quantitative techniques are used to measure directly the observed usability levels, in order to compare them against the specified levels set in the usability specifications. We will use two main types of quantitative data generation methods that are most often used in formative evaluation.

(1) Benchmark Tasks:

During the experiment, each participant performs the prescribed benchmark tasks, and the evaluator takes numeric data, depending on what is being measured.

(2) User Preference Questionnaires:

User preference questionnaires refer to categorical rankings (e.g. from 0 to 9, or from –2 to 2, or from strongly agree to strongly disagree) for different features that are relevant to the usability of the interface being evaluated. Questionnaires are the most effective technique for producing quantitative data on subjective user opinion of an interface.

Qualitative Data

These are nonnumeric data and results, such as lists of problems users had while using the interface. Qualitative data result in suggestions for modifications to improve the interaction design. In order to get qualitative data, which is extremely important in performing formative evaluation, we will use the following two methods:

(1) Critical Incident Taking:

A critical incident is something that happens while a participant is working on the test and that has a significant effect, either negative or positive, on task performance or user satisfaction. Critical incident data help focus analysis of the qualitative data. A bad or negative critical incident is typically a problem a participant encounters. An occurrence that causes a participant to express satisfaction or closure in some way is a good or positive critical incident.

(2) Structured Interviews:

Structured interviews are generally in the form of a post-experiment interview, a series of preplanned questions that the evaluator asks each participant. A typical post-session interview might include, for example, such general questions as "What did you like best about the interface?", "What did you like least?", and "How would you change the interface?".

Metrics

The value to be measured is the metric for which data values are collected, the specific data to be collected during an evaluation session with a participant. In our study, the length of time to complete a specific task will be the primary value to measure. Another measure will be the number of errors user makes while performing a task. "Time to complete a task" and "number of errors during task performance" are, in fact, the most common objective values measured.

Data Analysis

The first step in analyzing the data is to compute averages and any other values stated in the usability specifications for timing, error counts, and questionnaire ratings.

We will collect data during the experiment and record it in the usability specification table, and we will also gather information from post-task questionnaires. We will develop the specific mechanics for data collection prior to the experiment by running one or two participants through a pilot test one week before the experiment.

Next, we will enter a summary of the results into the observed result column of the usability specification. By comparing the observed results with the specified benchmarks, we will be able to tell which usability specifications have been met and which have not been met.

We will prepare charts and graphs form the collected data. Tabulating qualitative input will enable the group to analyze data collected from the post-task questionnaire.

Data analysis will focus on determining problem areas concerning the human-computer interface.

Pilot Testing

We made several modifications to our methodology after conducting pilot testing. Most of the changes we made concerned the benchmark task conditions on the task list and the Usability Attribute Table. For example, one task asked the participant to take the helicopter to an elevation of 5000 feet. During pilot testing, we found that it took a very long time to complete the task. The helicopter does not increase its altitude very quickly, so we determined that 200 feet would be more reasonable. We also determined that the task was to evaluate how well the user could figure out how to increase the altitude, rather than whether or not the user could take the helicopter to exactly 2000 feet.

We also changed some terminology in the task list. For example, changing the speed of the tank from "20 knots", which is more appropriate for ships, to "20 mph", which is more appropriate for tanks. Some changes were very subtle, like saying, "rotate the main gun," instead of, "turn the main gun." In this case, the word "turn" made the participants mistakenly think that the task was to turn the entire tank, rather than simply rotating the turret. One task in particular was found to be very challenging and interesting. This task required the user to return the vehicle to the start position. Some participants noticed a button labeled "home" on the control panel and correctly guessed that this button would return the vehicle to the start position. Other participants drove the vehicle around the desert looking for the start position.

During pilot testing, we discovered that the software crashed often. This provided us with an opportunity to discuss protocol for handling such events. In the event of a crash, the observer would attempt to return the game to the same state prior to the crash.

Protocol

Objective

The objective of this study is to evaluate the effectiveness of the user interface of the Capture the Flag application and to recommend alternatives for improving human computer interaction in future versions of the application. The study will evaluate the entire interface, as opposed to limiting its scope to vehicle control panels or graphical displays. The entire interface includes the control panels, the console windows, input devices, and the virtual reality graphical display. The study will also include the system's computing platform, since this is a game that is heavily dependent upon audio and visual sensory output to the user. The study will also include the environment, in which the game is played. The game is intended to be played in teams, where the opposing teams and even players on the same team may be geographically separated or co-located. We feel that the environment may play a role in the user interface's effectiveness.

Method

The participant will be given some basic instruction on how to start the game and the game's objective. The participant will then be allowed to play with the game for approximately ten minutes. Afterwards, the participant will complete an initial impression questionnaire. Then the participant will be given a list of tasks to perform. The participant will be asked to answer some post task questions during the test in order to collect qualitative data. After completing all tasks, the participant will complete a post test questionnaire. The entire test will last no longer than one hour per participant.

Equipment

The experiment will be conducted using either an NT or SGI workstation. The participant will sit at the monitor and play the game via the keyboard.

Risks

This research involves no risks or discomforts greater than those encountered in daily life.

Safety Measures

The experimenter will be present continuously and will monitor the safety of the procedure. In the unlikely event of a medical emergency or natural disaster, the experiment will be stopped immediately.

Subjects

No more than 15 volunteers will be recruited. The participants will participate in one one-hour session.

Confidentiality

Collected data will not be associated with the name of the participants. Each participant will receive a random number, which will serve as the only identification used to index the results and questionnaires.

Consent

Participants will be asked to sign a consent form before the start of the experiment. Participants will be given the names and telephone numbers of the experimenters so that they are able to voice any concerns at anytime.

Results

The following document contains six sections:

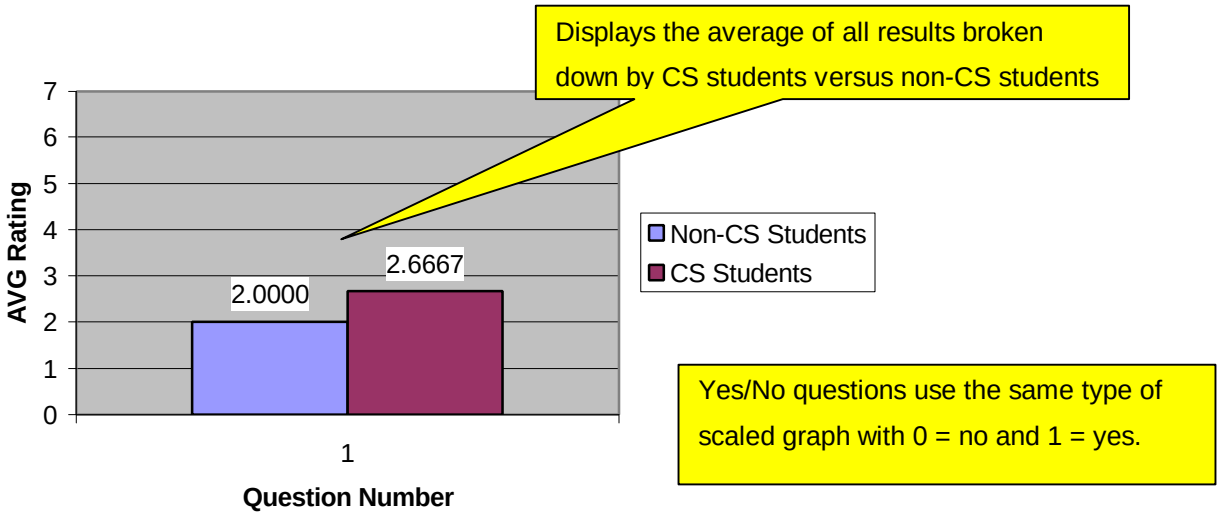
1. Pre-Questionnaire Results
2. Post-Task Questionnaire Results
3. Post-Test Questionnaire Results
4. Usability Specifications Data
5. Post-Task Questionnaire Data
6. Post-Test Questionnaire Data

Questionnaire Results

The first three sections consolidate the results from all of the questionnaires and presents the results in the following manner:

Scale Questions and Yes/No Questions

Questions that asked a user to rate how easy/difficult it was to complete a task on a scale from 0 to 7 (0 = very easy, 7 = very difficult) are presented in the form of a graph. Questions that asked a user a yes/no question are also presented in the form of a graph. The graphs are explained below:



Qualitative Short Answer Questions

These are presented in a text box. Each bullet represents a comment made by a single participant. An example follows:

- But the start icon must be disabled before I select the team. Make it disabled and then able it after I select the team.
- Should not need to press start button.
- Bigger buttons.
- Why do we need to push start button after selecting team?

Raw Data

The last three sections present a consolidated view of all of the raw data collected during the evaluation. The raw data sheets also display the average results per question or task; and, in the case of the questionnaire data, the sheets also display the standard deviations.

Comments

Most of the study questions we want to answer by conducting this study involve determining how easy or how difficult it is to use specific interface components and how to improve the interface design. The raw data from the questionnaires is not very useful for the analyst for this particular task. An analyst cannot quickly scan the raw data and get a feel for how difficult it was to use the interface. However, calculating the averages for the answers, sub-dividing the averages by CS vs. non-CS participants, and then placing the averages in bar charts provides the analyst with a graphical tool for analysis that is much easier to use than the raw data. A quick run-through of the charts gives an analyst a feel for how easy or how difficult it is to use the interface in general. The charts and bulletized presentation of the results enable an analyst to quickly identify problems and to see what all the participants had to say about a particular task or interface component. From here, an analyst can then recommend a design solution for the problem.

Pre - Questionnaire Results

1. What is your first impression of Team Selection panel?

- Very simple and understandable.
- Good.
- Bigger than necessary.
- Buttons are too small, not attractive.
- Something with banner related to the team would be better or picture.
- The buttons are too small.
- It is not bad.
- There are two teams, red and blue.
- Clear.
- Easy.
- It does not represent the correct function.
- Clear.

2. What is your first impression of Vehicle Selection Panel?

- Has technical terms, complex.
- Difficult to understand.
- Complicated.
- Panel is small, buttons and text are small.
- Not bad.
- Too much information.
- Nice.
- The names of the buttons are not readable.
- Clear.
- Not bad.
- Confusing.
- Some fields do not make any sense. Glad it has some default values.

3. What does the Multicast Address ext field in the Vehicle Selection Panel represent to you?

- I don't understand.
- Nothing.
- Nothing.
- Our IP address.
- Nothing.
- Nothing.
- Number of the computer.
- Network IP address.
- Something like an IP address.
- Something like an IP.
- Nothing.
- Nothing.

4. What does the Port Number in the Vehicle Selection Panel represent to you?

- I have no idea.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Schools assigned number to computer.
- Nothing.
- Nothing.
- For data communication.
- Nothing.
- Nothing.

5. What does the Site ID in the Vehicle Selection Panel represent to you?

- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Probably it shows the playing site.
- Nothing.
- Nothing.
- Nothing.

6. What does the Application ID in the Vehicle Selection Panel represent to you?

- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- Nothing.
- The number assigned to game.
- Nothing.
- Nothing.
- Working application's number.
- Nothing.
- Nothing.

7. What does the Player Identification in the Vehicle Selection Panel represent to you?

- Type of vehicles that I will use. Recommendation: Type of Vehicle should be used instead of "Player Identification".
- I think it represents kind of weapons (tank or helicopter).
- Nothing.
- Vehicle name and vehicle type.
- Makes sense, easy to understand.
- This is what I need for the game. I should be able to access the others by menu.
- Players using vehicles.
- Vehicle names and call signs.
- You can select a vehicle.
- The number might be either number of vehicles or the ID of the vehicle.
- Selecting a vehicle.
- Does not make sense.

8. What is your first impression of the Vehicle Control Panel?

- It is compressed.
- It looks fine for major controls in the vehicle.
- Complicated.
- It is not partitioned according to the functionality.
- Complicated, not easy to understand. Does not make sense.
- It is not immediately obvious, buttons are small.
- Nice and compact.
- Clear and understandable.
- There is no help icon.
- Places of buttons are not correct and confusing.
- Pretty complicated. Lots of stuff on it.

9. What does the left area of the Vehicle Control Panel represent to you?

- Weapon and tank control.
- Major visual control instruments like speed, turning, gun control, etc.
- Speed and direction.
- Inside of the tank.
- Not easy to group the idea.
- Fine control.
- Tank control panel.
- Tank's movement controls.
- Easy to understand.
- Not very clear.
- Tank maneuver functionality and fire controls.
- Controls for the vehicle.

10. What does the middle area of the Control Panel represent to you?

- No idea.
- Nothing.
- Nothing.
- Viewing area.
- Nothing.
- Nothing. (map)
- The path or map.
- Map or view.
- Nothing.
- Nothing.
- Nothing.
- What's that?

11. What does the right area of the control panel represent to you?

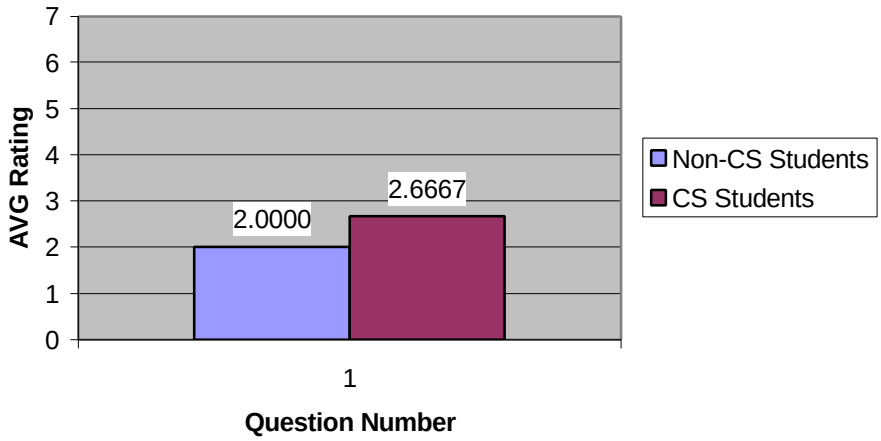
- Turret control.
- Some other controls. Gun control, brakes, turret, changing vehicle.
- Gun control and turning.
- Turret control.
- New vehicle, home does not make sense.
- Gross control. They are mixed.
- Firing system controls.
- Gun and turret controls.
- Lower gun and raise gun. Could be next to each other.
- Clear.
- Nothing.
- Controls for the gun.

12. What is your first impression of the VRML display?

- Nice view.
- Display is good. But maybe more colorful display would be better.
- Vehicles are not clear. No meaning of red wall.
- The graphical display is not good.
- Good.
- Looks good.
- Nice.
- Nice.
- Normal.
- Buttons not very helpful.
- Nice.
- Not bad. Where is the control menu?

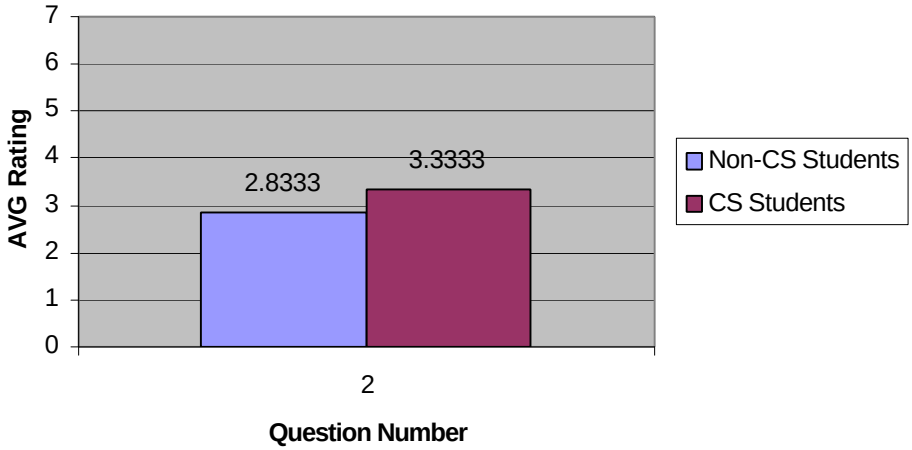
Post - Task Questionnaire Results

1. How easy / difficult was to select a team and start the game?



- But the start icon must be disabled before I select the team. Make it disabled and then able it after I select the team.
- Should not need to press start button.
- Bigger buttons.
- Why do we need to push start button after selecting team?
- Double clicking should be fine, extra start button is confusing.

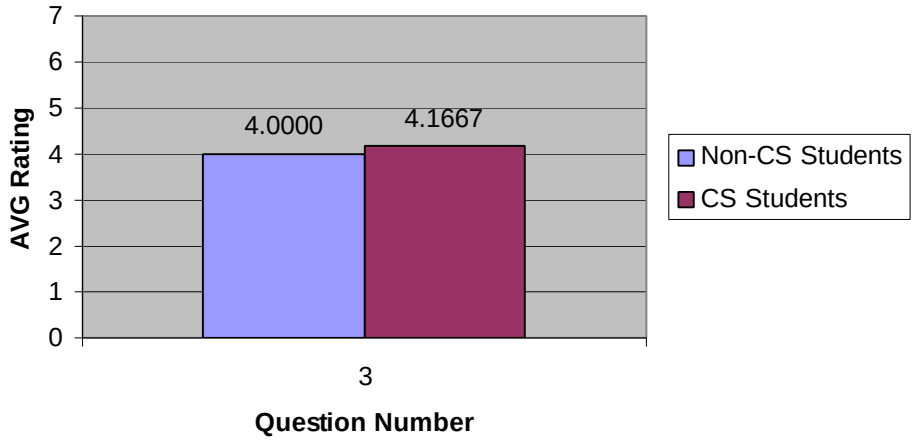
2. How easy / difficult was it to pick a vehicle?



- It was not clear how to select the vehicle. One click should be enough to select the vehicle (tank).
- But order the vehicles as type like helo, tank.
- Vehicle names are unnecessary.
- Too much extra info. Put the additional info in a menu system.
- “New vehicle” prompt can be shown on the menu in a different character series (color e.g.).

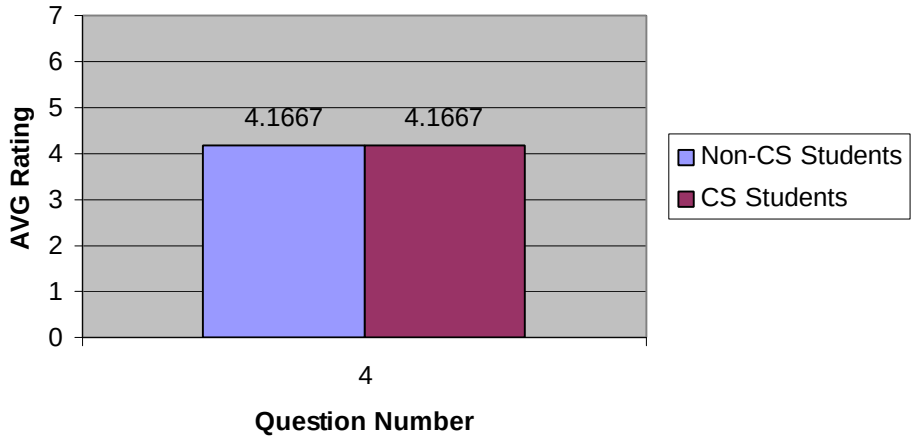
- Still don't know what player ID 37 is.

3. How easy / difficult was it to decide the type of the vehicle from its name?



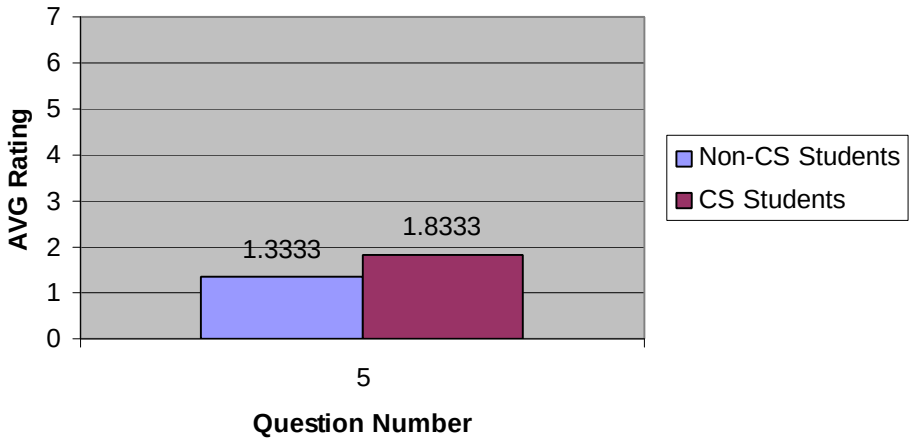
- I don't know the names. Giving the names more precisely (M-60 Abraham) would be better.
- I am not an army guy so I could not distinguish one from the other.
- I could have figured it out with a few minutes of thought.
- Tanks and helos can be listed with different columns.
- Clear explanation would be better.

4. How easy / difficult was it to change the viewpoint of your tank?



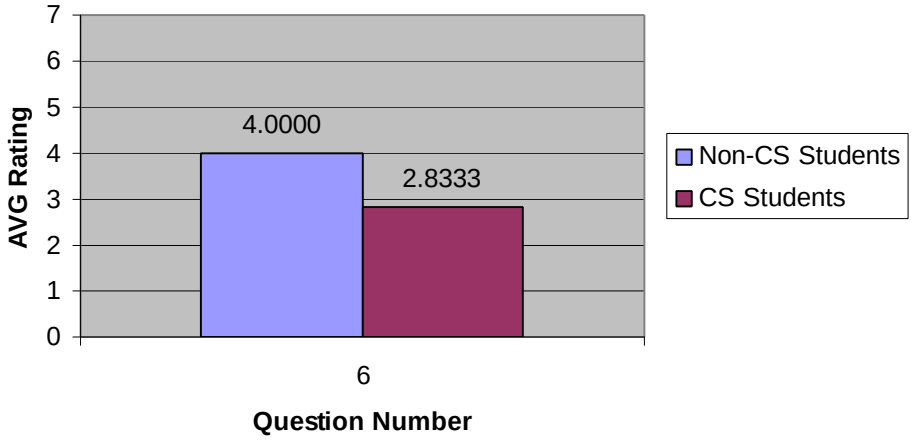
- It was difficult to find. Putting the "viewpoint list" on the display clearly would be better.
- But hard to see the icon.
- Viewpoint change button is small and it does not convey and meaning.
- Only because I have used VRML before. Put the viewpoint buttons on the control panel.
- The viewpoint selection button is too small.
- Could be better if some menu options were available.

5. How easy / difficult was it to increase the speed of the tank?



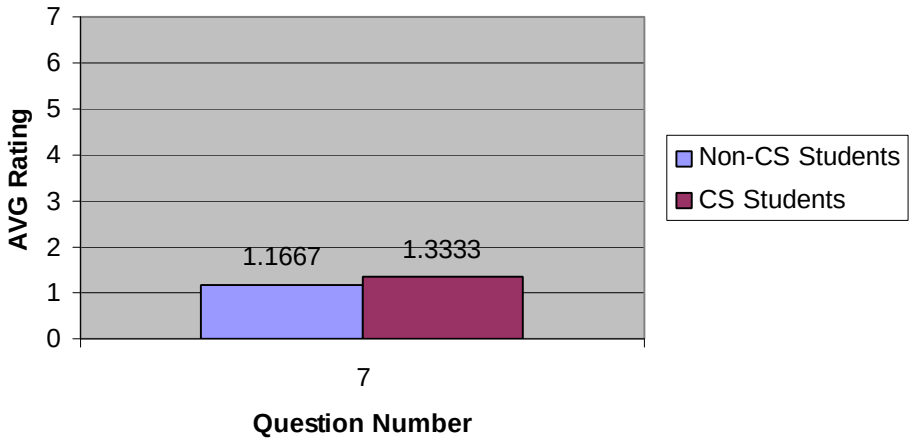
- It was easy.
- Easy.
- It should be entered directly by keyboard.
- Slider bars are good.

6. How easy / difficult was it to change the heading of the tank?



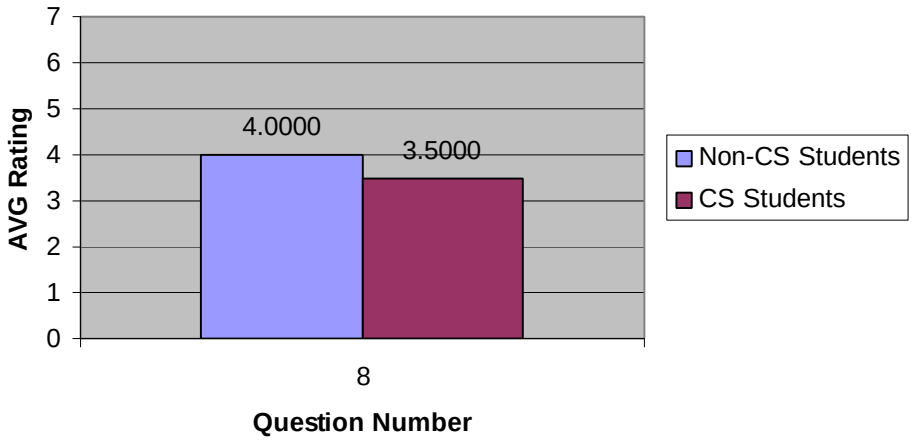
- It was difficult for me to understand. There should be more explanation.
- I could not distinguish the turn rate control panel.

7. How easy / difficult was it to stop the tank?



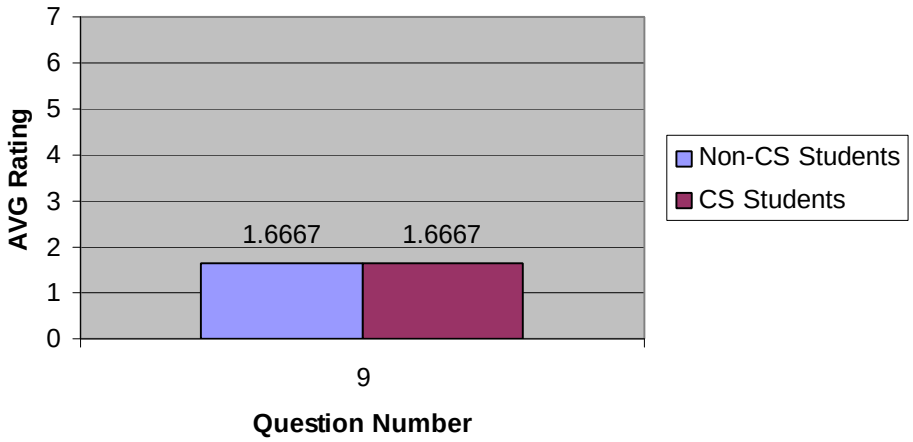
- Make speed control 0 (round?).
- Why does the reverse button stop the tank?

8. How easy / difficult was it to take the tank to the game starting position?



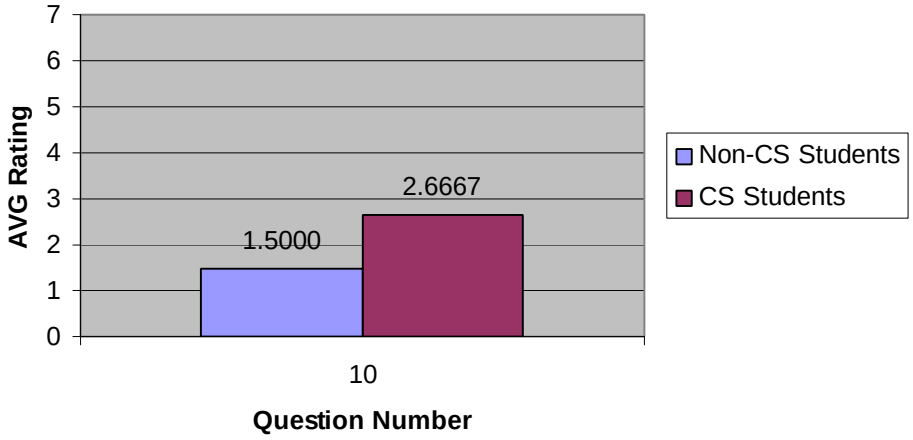
- It was difficult for me to understand what “home” means. It should be like “starting point” or “reset”, “new game”.
- Very easy.
- Button is lost among turret controls. Move it or make it stand-alone.
- “Home” cannot be seen easily. It can be located another unique place and written bigger.
- The button did not make much sense.

9. How easy / difficult was it to proceed the tank in the reverse direction?



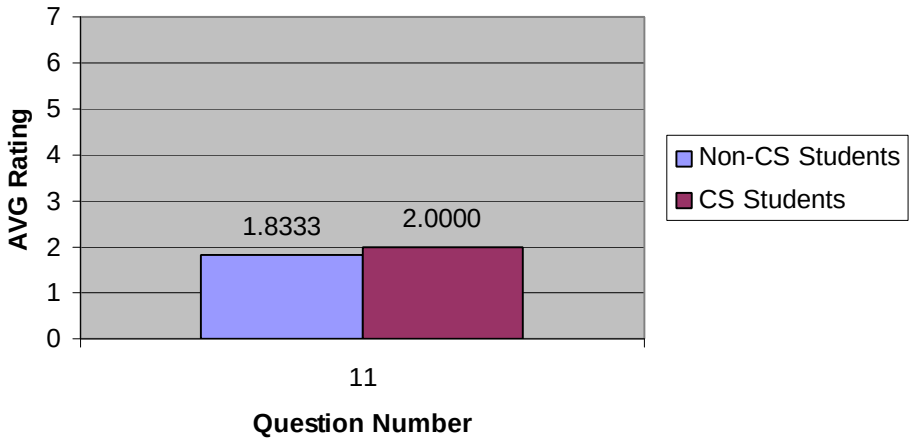
- But after reversing I could not make the speed (-10).
- The speed control panel should have negative speeds.

10. How easy / difficult was it to increase the elevation of the main gun?



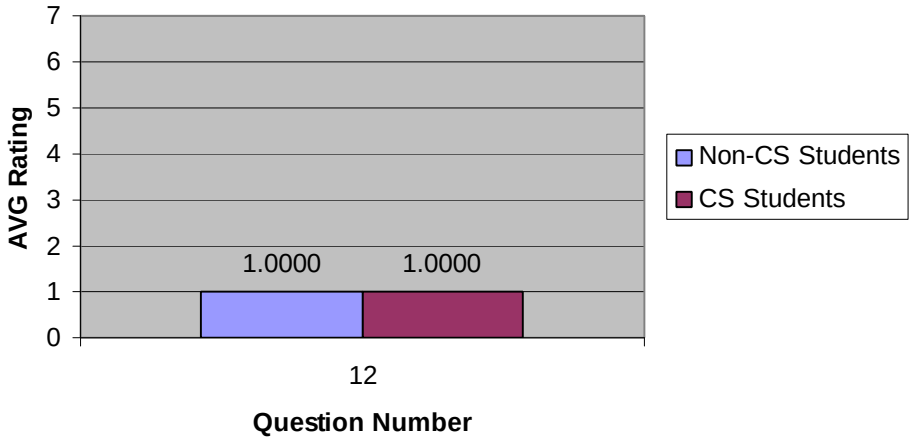
- Easy.
- It is not sensitive, increases/decreases by 4.
- Not so easy to stop it. I assumed 1 click meant 1 degree of change like speed.
- The labels are not readable.
- Stopping increasing the elevation is not easy to find out.
- The button actions are strange.

11. How easy / difficult was it to rotate the main gun?



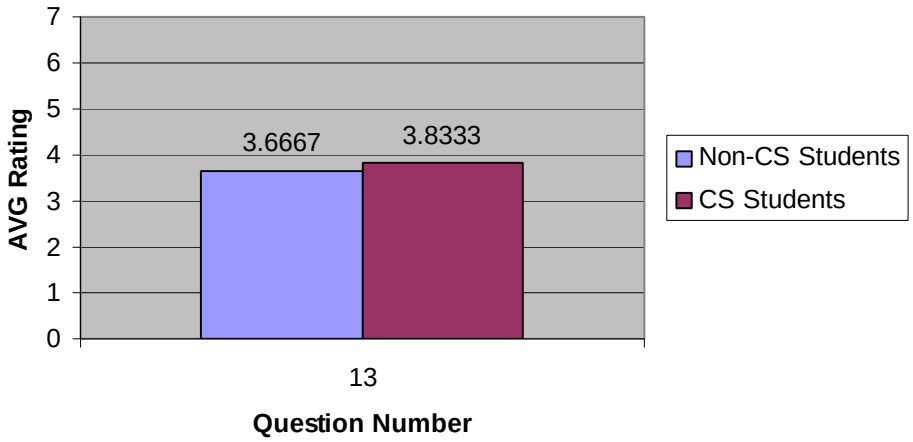
- I am not sure about the actual heading of the turret.
- Easy if the icons are understandable.
- Not so easy to stop it. (I figured it out before this task.)
- You want to see the direction of your gun numerically (relative or real [actual]).
- There is no heading indicator for turret.

12. How easy / difficult was it to fire the guns?



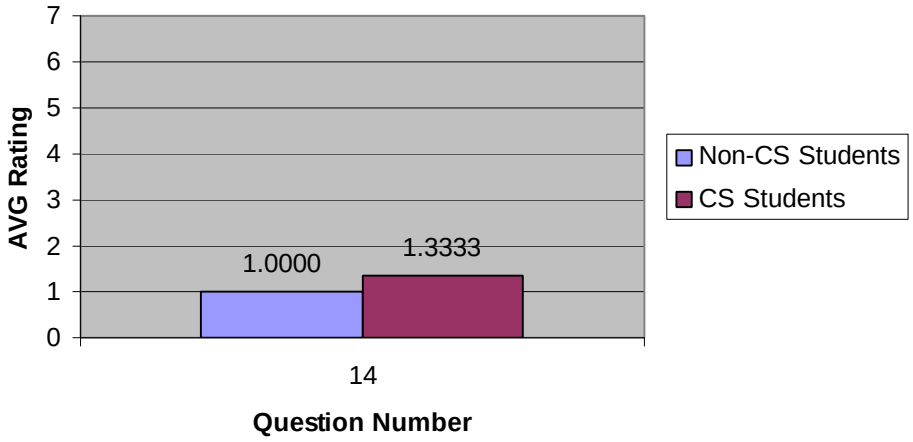
- Easy.
- There is no feedback.

13. How easy / difficult was it to change the altitude of the helicopter?



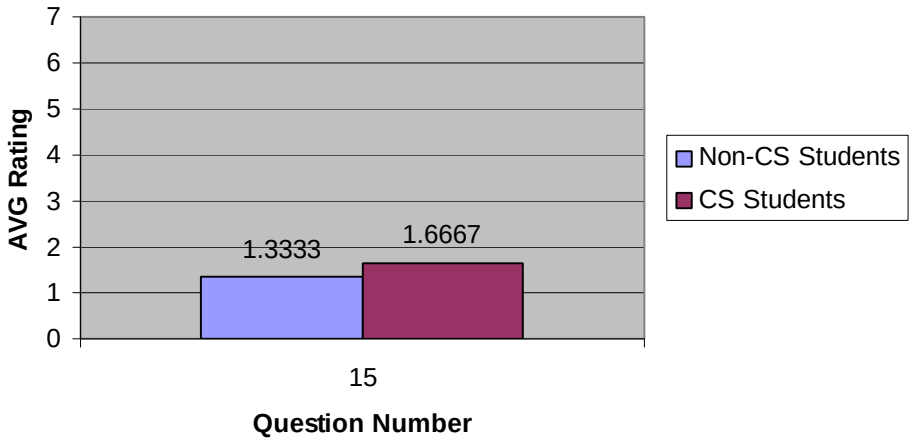
- Control panel and button names are confusing.
- It was difficult to understand. Instead of “vertical thrust”, “take off” would be easier for me.
- Hard to understand torque(ver. thrust) is that icon.
- Instead of torque we can use thrust.
- First I had to figure out the button. The label was not helpful/clear.

14. How easy / difficult was it to speed up the helicopter?



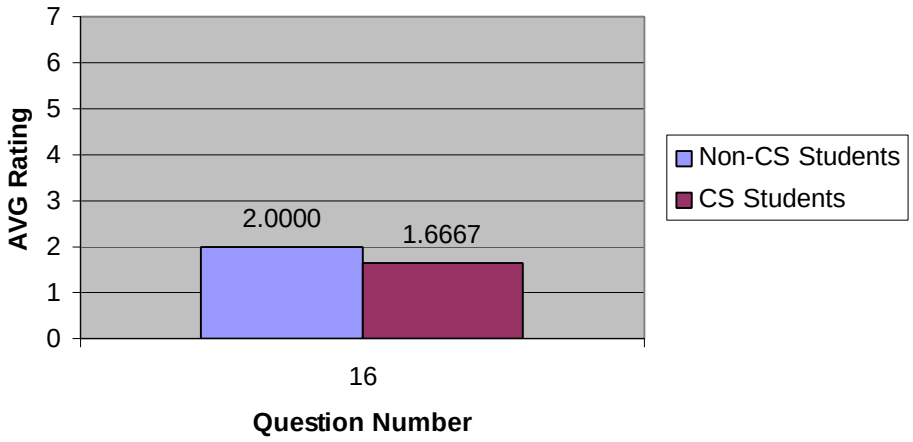
- Easy.
- Instead of torque you should use something else.

15. How easy / difficult was it to change the heading of the helicopter?



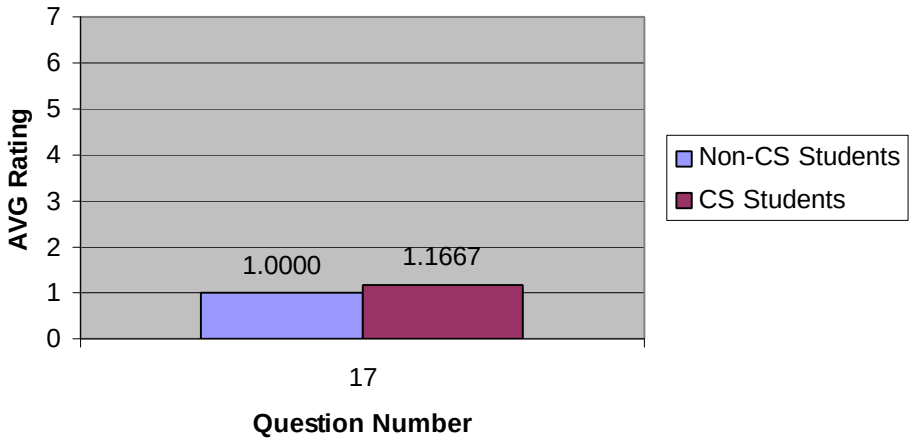
- Very easy.
- I missed the turn buttons at first and complained that I had to bank to change heading.

16. How easy / difficult was it to take the helicopter to the hover position?



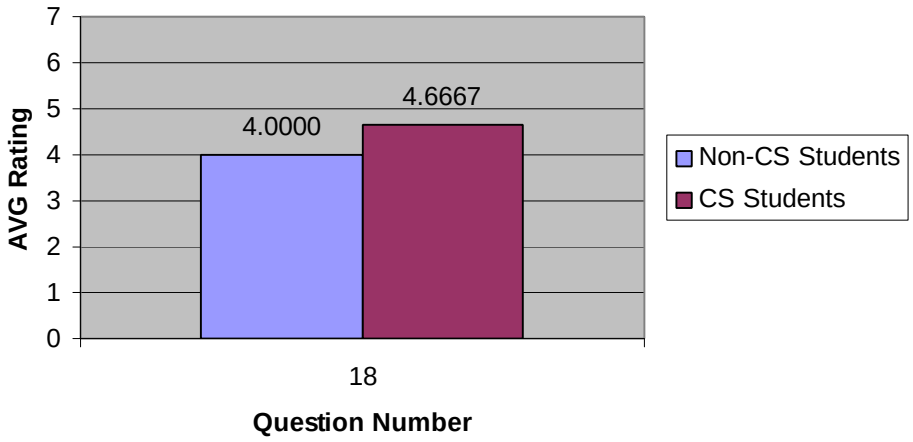
- Easy.
- Hover button should be on left side.
- Two methods available and one on each side of control panel was easy.
- Hover button did not make much sense, and the little button was hard to find.

17. How easy / difficult was it to fire the helicopter rocket?



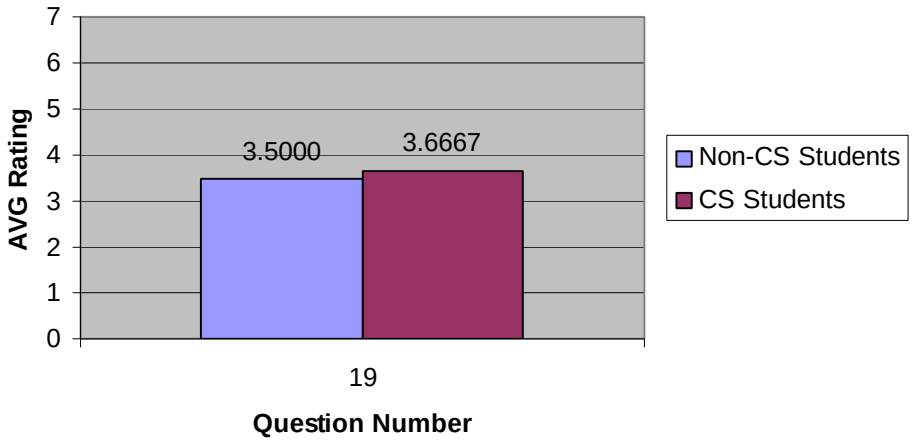
- Easy.
- No feedback after firing.

18. How easy / difficult was it to aim at a stationary target from a helicopter?



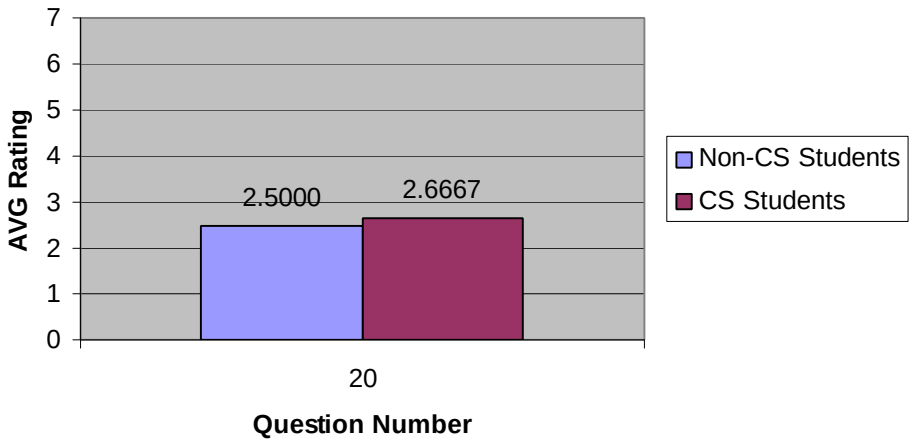
- It was difficult to control.
- Cockpit view did not allow me to see through the aim reticule.
- There is no indicator.
- It was difficult to control the helicopter.

19. How easy / difficult was it to pick up the flag using the helicopter?



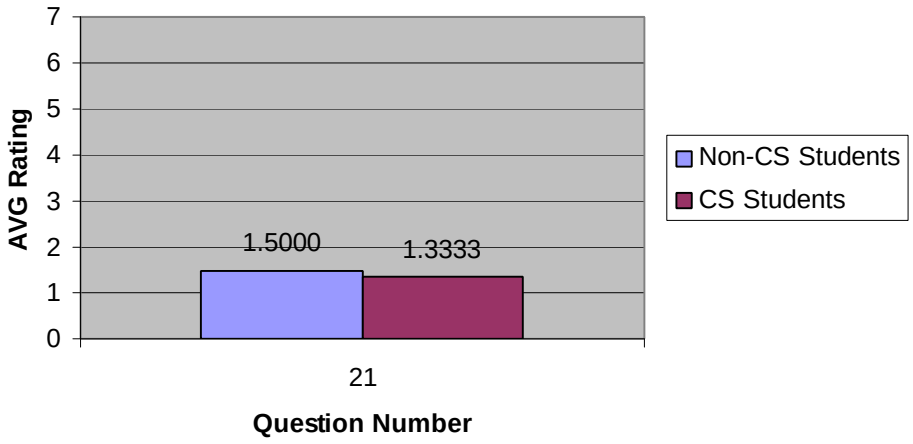
- Difficult to find direction.

20. How easy / difficult was it to aim at a stationary target from a tank?



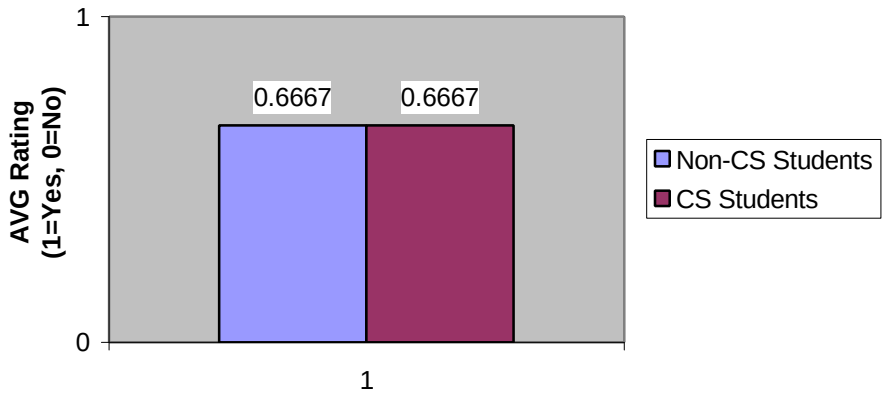
- A turret direction readout would be nice.

21. How easy / difficult was it to pick up the flag using a tank?



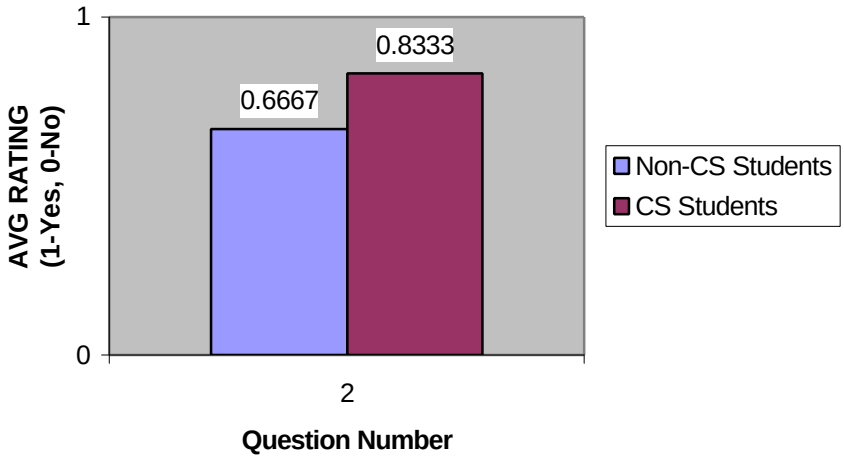
Post - Test Questionnaire Results

1. Was the layout of the control panel confusing?



- All the related functions can be places closer such as heading and right turn, left turn.
- Heading control should be close to turn rate control. Brakes location is not good. Related controls have same color.
- Some buttons were not "task organized" i.e. Fine controls vs. Gross controls.
- The labels are a little small, hard to read first.
- Different colors different character dimensions and types can be used in order to classify commands and information.
- Little bit.
- The background color of control buttons and indicator may be changed.
- Labels are too small.

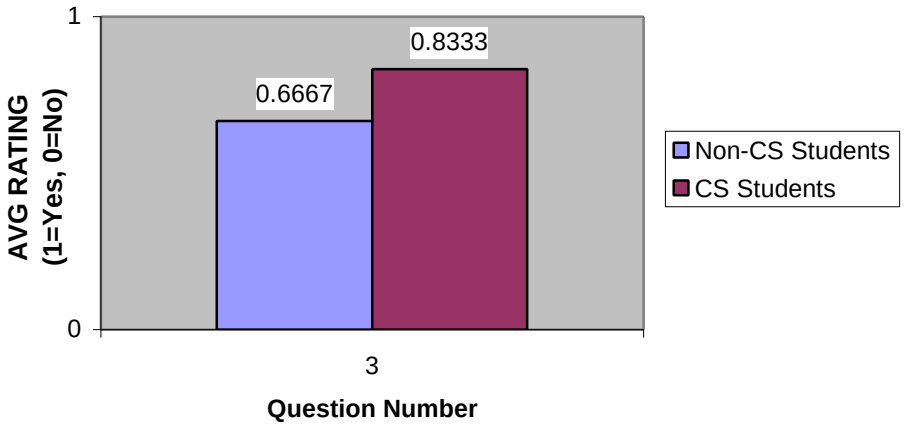
2. Did the military jargon used in the panels make sense?



- But if I were a civilian they wouldn't make any sense
- Especially those for helos are not clear.

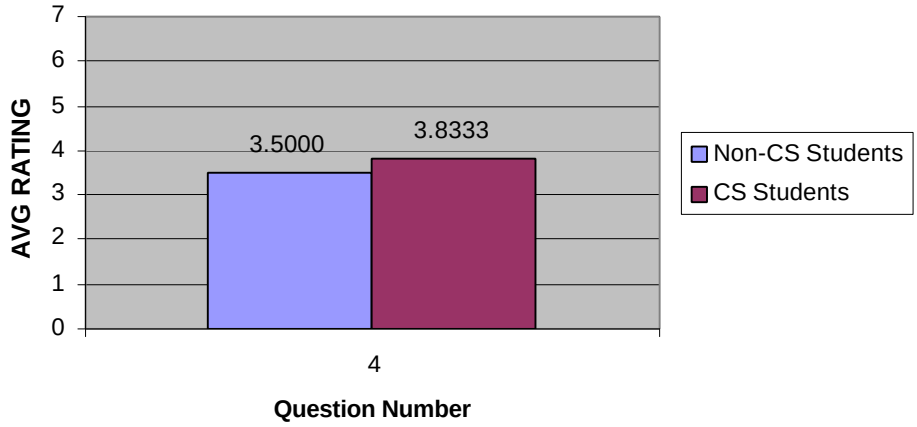
- They may be more descriptive.
- I'm not very familiar with jargon.

3. Are the input devices appropriate to control the vehicles?



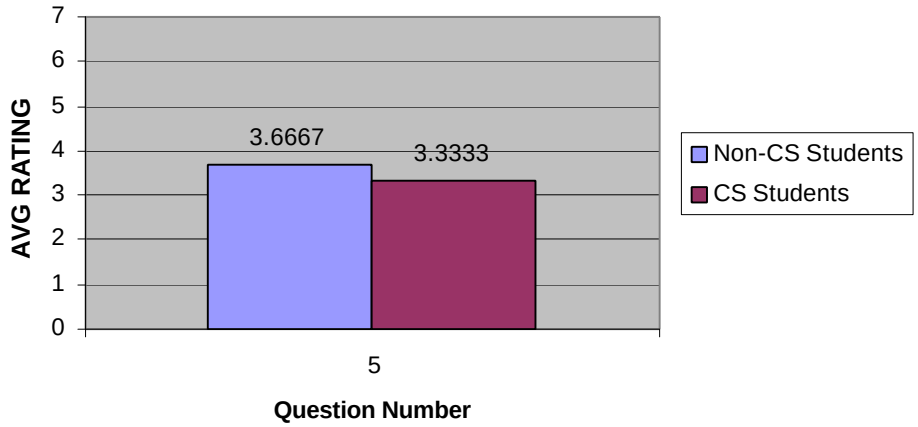
- Some controls are not clear. It should be more precise.
- I don't like the mouse, but it is the best that there is for general purpose input devices.
- At first sight, I couldn't understand which one controls which (like elevation, heading, etc.). I was looking for the controls near them.
- When you push the button, the button color or something should change.

4. How well does the game environment reflect the battlefield situation?



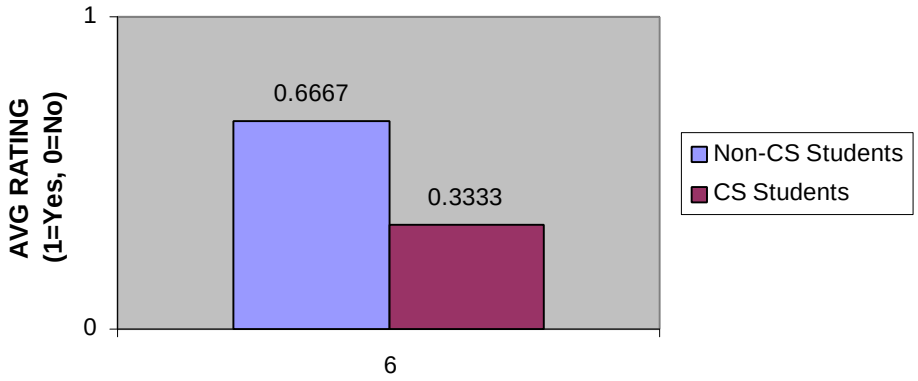
- Game environment lacks of details. It pictures only a general context.
- I had no idea where anything was.
- Not much details.

5. How well do the control panels interact with the display?



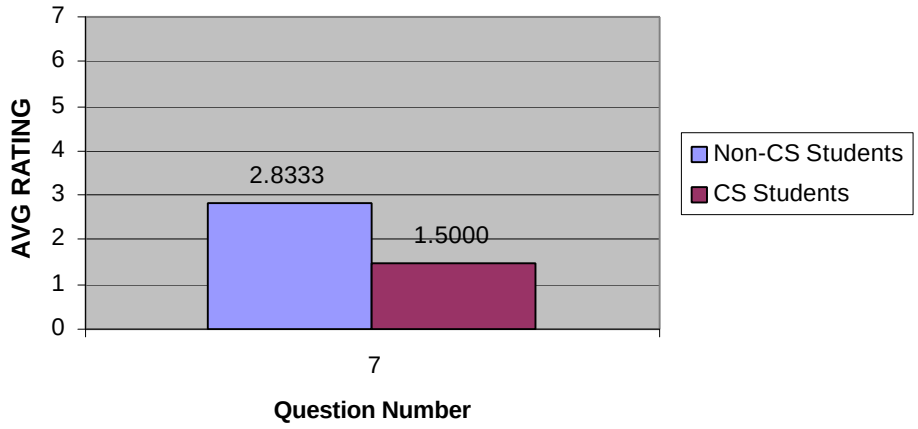
- Somewhat slow response to dynamic commands (turns, etc…).
- I don't understand where I am on the field. Needs kind of a map on the panel that shows the vehicle.
- You need a general bird-eye view.
- It has slow response.

6. Did the functionality of each control element reflect what you had expected?



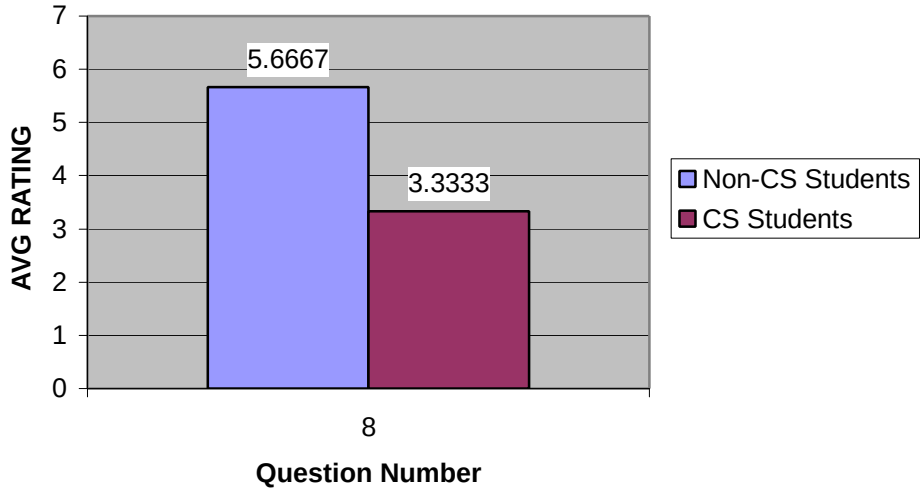
- I expected to have aiming information when I tried to destroy enemy vehicle
- It was difficult to be precise. It should stop (e.g. turning) when you press the control button.
- Turn right/left control was difficult.
- Tank turret controls were not same format as spd/dir. Use only one format.
- Elevation control of helicopter was not easy.

7. How easy were the rules of the game to understand?



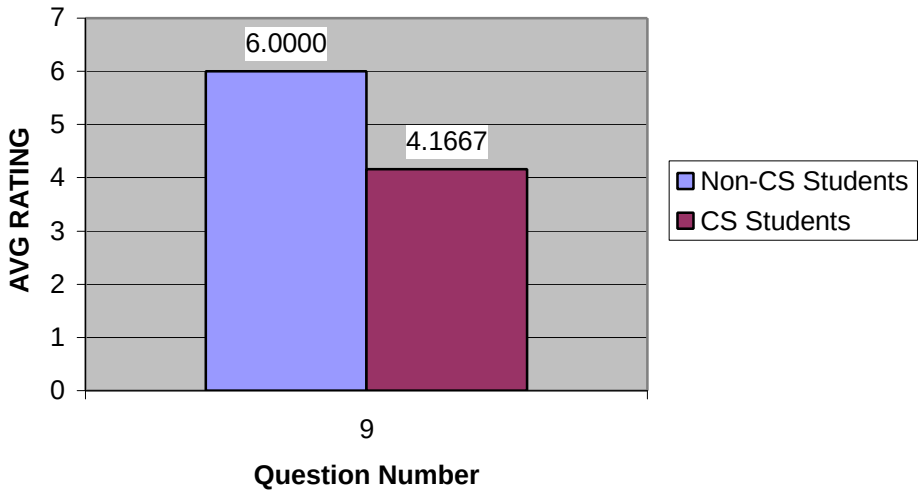
- But if you add an introduction reviewing the rules of the game before entering the game, it'll be helpful to users.
- Map would help.
- A better instruction manual or helpdesk on the screen.
- Some sort of mission description at the beginning.

8. How easy/difficult was it to play the game?



- It was very difficult to find the opponent team's base.
- It is burdensome to change view every time a new vehicle is selected.
- It was hard to control the vehicles.
- There was no indication whether a vehicle is RED or BLUE.
- It would be better if we had heading information for tank turrets.
- It was very hard to change view.

9. How challenging was it to capture the flag?



- It was very difficult.
- I did not know the speed constraint.
- It is very difficult to capture it with the helicopter.
- It is very hard to capture the flag with a helicopter.

10. What collaboration tools should be added to the system.

- Map and vehicle color/markings.
- Radar and vehicle color/markings.
- Map and vehicle color/markings.
- Map and chat.
- Map and audio communications.
- Radar and vehicle color/markings.
- Map and vehicle color/markings.
- Map and vehicle color/markings.
- Map and vehicle color/markings.
- Radar, chat, and vehicle color/markings.
- Map and vehicle color/markings.
- Map and vehicle color/markings.

Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST possible LEVEL	CS AVERAGE	NON-CS AVERAGE
1	Initial Performance	Selecting a team and proceeding to "Vehicle Selection Panel" on the first trial	Length of time for proceeding to "Vehicle Selection Panel"	NA	5 Sec	3 Sec	2 Sec	3.0000	4.1667
2	Initial Performance	Selecting a vehicle and proceeding to "Vehicle Control Panel" on the first trial	Length of time for proceeding to "Vehicle Control Panel"	NA	6 Sec	4 Sec	2 Sec	2.0000	4.3333
3	Initial Performance	Changing the viewpoint to the vehicle on the first trial	Number of errors on the first trial	NA	5 Errors	2 Errors	0 Error	4.1667	3.3333
4	Initial Performance	Changing the speed of the tank to a given speed	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	2.6667	2.6667
5	Initial Performance	Changing the heading of the tank to a given course	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	4.1667	12.8333
6	Initial Performance	Stopping the tank	Length of time on the first trial	NA	4 Sec	2 Sec	1 Sec	1.1667	1.3333
7	Initial Performance	Proceeding the tank in the reverse direction with a given speed	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	2.1667	3.0000

Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST possible LEVEL	CS AVERAGE	NON-CS AVERAGE
8	Initial Performance	Taking the tank to the starting position	Length of time on the first trial	NA	5 Sec	3 Sec	1 Sec	9.5000	27.8333
9	Initial Performance	Increasing the elevation of the main gun to the given elevation	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	4.6667	6.0000
10	Initial Performance	Decreasing the elevation of the main gun to the given elevation	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	2.6667	3.0000
11	Initial Performance	Rotating the main gun to the right	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	3.0000	3.0000
12	Initial Performance	Rotating the main gun to the left	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	2.5000	2.3333
13	Initial Performance	Firing the main gun	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	1.6667	1.8333
14	Initial Performance	Firing the auxiliary gun	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	1.1667	1.3333

Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST POSSIBLE LEVEL	CS AVERAGE	NON-CS AVERAGE
15	Learnability	Selecting a team and proceeding to "Vehicle Selection Panel"	Length of time for proceeding to "Vehicle Selection Panel"	NA	4 Sec	2 Sec	1 Sec	18.5000	10.8333
16	Learnability	Selecting a helicopter	Length of time	NA	4 Sec	2 Sec	1 Sec	1.3333	1.5000
17	Learnability	Changing the viewpoint to the vehicle	Length of time	NA	4 Sec	2 Sec	1 Sec	2.0000	2.5000
18	Initial Performance	Changing the altitude of the helicopter	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	9.0000	16.8333
19	Initial Performance	Speeding up the helicopter	Length of time on the first trial	NA	6 Sec	4 Sec	2 Sec	1.5000	1.8333
20	Initial Performance	Turning the helicopter to the right	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	2.0000	4.3333
21	Initial Performance	Turning the helicopter to the left	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	1.5000	1.5000

Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST POSSIBLE LEVEL	CS AVERAGE	NON-CS AVERAGE
22	Initial Performance	Taking the hover position	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	2.1667	2.8333
23	Learnability	Having the helicopter to the starting position	Length of time on the first trial	NA	5 Sec	3 Sec	1 Sec	1.0000	1.6667
24	Initial Performance	Firing the rocket of the helo	Length of the time to find the fire button	NA	4 Sec	2 Sec	1 Sec	1.0000	1.0000
25	Initial Performance	Changing viewpoint to Cockpit	Number of errors	NA	3 Error	0 Error	0 Sec	4.8333	2.1667
26	Learnability	Firing the main gun of the tank to a given direction and elevation	Length of the time	NA	10 Sec	7 Sec	4 Sec	6.5000	8.6667
27	Learnability	Firing the rocket of the helo from a given altitude to a given direction	Length of the time	NA	10 Sec	7 Sec	4 Sec	6.8333	9.8333
28	Learnability	Destroying a stationary tank with a rocket fired from a helicopter	Length of the time	NA	10 Sec	7 Sec	4 Sec	11.1667	18.0000

Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST POSSIBLE LEVEL	CS AVERAGE	NON-CS AVERAGE
29	Initial Performance	Picking up the flag using a helicopter	Length of the time	NA	10 Sec	7 Sec	4 Sec	22.0000	26.3333
30	Learnability	Destroying a stationary tank with the main gun of the tank	Length of the time	NA	10 Sec	7 Sec	4 Sec	6.5000	10.5000
31	Initial Performance	Picking up the flag using a tank	Length of the time	NA	10 Sec	7 Sec	4 Sec	13.1667	13.1667

Recommendations and Conclusions

Summary

The following tables contain discussions concerning tasks, for which the majority of users exceeded the worst acceptable time for completion or the maximum number of acceptable errors. The worst acceptable times and maximum acceptable errors are specified in the Usability Specifications Table. Recommendations concerning the following tasks are provided in the following section, **Recommendations**.

Task # 8: Take the tank to the starting position
Worst Acceptable Level: 5 seconds
Average Performance: 18.6 seconds

Seventy-five percent of the participants exceeded the worst acceptable level in completing this task. The participants, who completed the task within five seconds, actually completed the task in one to three seconds. The participants, who exceeded the worst acceptable level, completed the task between seven seconds and 67 seconds. The large difference in times between those who completed the task in five seconds and those who took longer can be explained by the **Home** button on the vehicle control panel. The **Home** button magically transports the player's vehicle to its original starting position. The time to complete the task was actually a measurement of the time it took for a participant to realize that the **Home** button might help them to accomplish the task.

The participants who attempted to drive back to the starting position exceeded the worst acceptable level. In fact, no participant successfully drove back to the starting position. The typical case went like this: Player attempts to find the starting position. Player realizes that there is not enough terrain features or anything whatsoever that identifies a piece of ground as the starting position. Player thinks that there must be a better way, so player looks for an alternative solution. Player discovers **Home** button on control panel and pushes it. Player correctly assumes that the button returned the vehicle to the starting position, although the system does not provide any clues that this is in fact true.

Another interesting result is that none of the non-CS students completed the task under eight seconds, while half of the CS students completed the task in three seconds or less. Our hypothesis is that perhaps CS students are used to using many different software programs and different GUIs, while non-CS students probably use popular office productivity and consumer retail software exclusively. Therefore, CS students are better prepared to assimilate a new GUI and its features.

Task #15: Switch to the other team
Worst Acceptable Level: 4 seconds
Average Performance: 14.7 seconds

This task required the participant to bring the Vehicle Selection Panel again in the middle of the game. Participants executed this task after they were already somewhat familiar with playing the game. Four seconds may be a bit too optimistic for a first-time user who is asked to execute this task for the first time. However, it is important to note that the task can be accomplished in two seconds by someone who knows the procedure. Therefore, participants took an average of twelve seconds figuring out which GUI component controlled the action for this task. It is also interesting to note that CS students took about eight seconds longer than non-CS students to accomplish this task. Our hypothesis is that the CS students have different expectations when using a graphical user interface than non-CS students. Changing sides is a game control rather than a vehicle control. Therefore, CS students may not have expected to find the controlling component on the Vehicle Control Panel.

Task #18: Change the altitude of the helicopter to 200 feet
Worst Acceptable Level: 8 seconds
Average Performance: 12.9

The task measured here was not how long it took to for the participant to reach 200 feet, but rather how long it took the participant to take the appropriate action to begin the ascent. Half of the participants executed this task in eight seconds or less. The meaning and purpose of the **Torque** slider control was not immediately obvious to many of the participants.

Task #30: Destroy a stationary tank with a rocket
Worst Acceptable Level: 10 seconds
Average Performance: 14.5 seconds

Seventy-five percent of all participants took longer than ten seconds to execute this task. Given the lack of aiming aids, limited visual feedback, and limited audio feedback, ten seconds may be too optimistic as a worst acceptable level.

It is interesting to note that almost all of the CS students outperformed all of the non-CS students on this task. We suppose that CS students are more familiar with computer games, or that CS students are better prepared to use the graphical user interface and the mouse.

Task #31: Pick up the flag using the helicopter Worst Acceptable Level: 10 seconds Average Performance: 24 seconds
Seventy-five percent of all participants took longer than twenty seconds to execute this task. The flag was very difficult to pick up, and many participants expressed frustration and dissatisfaction with the program during this task. The software contains rules for picking up the flag, which are not made apparent to the user. For example, the vehicle must pass within so many feet of the flag and cannot be going faster than a certain speed. Users are not aware of these rules and must discover them via trial and error, which can be frustrating and discouraging.

Recommendations

The following tables present issues and recommendations for the following components:

- Team Selection Panel
  - Start Button
- Vehicle Selection Panel
  - Network Text Fields
  - Vehicle Selection
- VRML Player
  - Viewpoint Settings
  - Viewpoint Options
  - VRML User Interface
- Helicopter Control Panel
  - Altitude Indicator and Above Ground Indicator
  - Torque Slider Control

- Tank Control Panel
  - Forward and Reverse Buttons
  - Firing the Gun
  - Turret Orientation
  - Turret Left/Right and Raise/Lower Gun Buttons
  - Brakes Button

- General Issues
  - Vehicle Control Panel Design
  - Collaboration
  - Software Crashes
  - New Vehicle Button
  - Home Button
  - Navigation
  - Audio
  - Overall GUI Design
    - Fragmented Presentation
    - Limited Input Device
    - Game Controls vs. Vehicle Controls

Team Selection Panel	
Issues	**Recommendations**
Start Button Participants were confused by the purpose of this button. Many mistakenly thought that the button started the game; when, in fact, it simply closed the dialog box and opened the Vehicle Selection Panel.	Redesign the team selection panel as follows: • Use radio buttons instead of push buttons, since both team buttons cannot be simultaneously selected • Change the **Start** button to an **OK** button that is disabled until either a **Red** or **Blue** radio button is selected

Vehicle Selection Panel	
Issues	**Recommendations**
Network Text Fields Participants did not know what these fields were for.	Remove the network fields from the vehicle selection panel and make them available via an **Advanced** button on the panel. The **Advanced** button would open a dialog panel with these fields and a short explanation for users to accept the default values. *See **General Issues** ® **Overall GUI Design** below for further recommendations.*

Vehicle Selection We had to explain to all participants how to select a vehicle. There probably is a bug in the program that does not allow a user to select a vehicle in the way that is considered normal. Instead of selecting a vehicle from a list and selecting start, the program requires the user to double-click or even double-click twice a vehicle in the list in order to select it. This is an undocumented bug or trick that we learned about from previous users of the program. If you don't know the trick, then you think that the vehicle selection panel does not work.	Fix the bug, such that a user selects a vehicle from the list and selects the **Start** button to begin the game.

VRML Player	
Issues	**Recommendations**
Viewpoint Settings Many participants did not understand the graphical user interface components of the Cosmo VRML player. Participants were particularly confused by the fact that the initial view when the game starts is not necessarily the view from their vehicle. The player must select the proper vehicle view by using the Viewpoint control component of the Cosmo	After the player selects the Start button from the Vehicle Selection Panel, the VRML view should automatically change to the view from the player's vehicle.

player UI after selecting the **Start** button from the **Vehicle Selection Panel**. Participants thought that they were unable to move their vehicle. They did not know that their vehicle was actually moving, because they were looking from the viewpoint of another vehicle when the game started.	
Viewpoint Options The Cosmo VRML player offers several views other than from the player's own vehicle, and some of these views are inappropriate for game play. For example, a player can select an opposing player's view.	The available views should be appropriate for game play. Views should be limited to views of the player's vehicle and to views from the player's vehicle. Not all of the VRML viewing options, such as, zooming and rotating, are appropriate for the game. Player views should be controlled by the game software and should be consistent with the rules (or the expected rules) of the game.
VRML User Interface Participants thought the VRML GUI was not really a "walk-up-and-use" user interface. Experimentation and experience was necessary to become familiar with the use of the controls. Participants generally found the VRML controls to be cool but unnecessary, and users frequently had to return to the original view setting in order to continue playing the game.	Do away with the Cosmo VRML player GUI and create one that is integrated into the design of the game. The VRML viewer contains viewing tools that are not consistent with the game, such as viewing the world from underneath the surface of the planet.

Helicopter Control Panel	
Issues	**Recommendations**
Altitude Indicator and Above Ground Indicator Participants were confused by the meaning of the term "altitude," as opposed to, the term "above ground." Most ignored the altitude indicator and used the above ground indicator exclusively since its meaning seemed to more important to them when flying a helicopter.	Get rid of the altitude indicator unless it is going to be used in the game. As the game is played now, the only meaningful indicator is the above ground indicator.
Torque Slider Control • The first problem encountered by participants using this control was figuring out its purpose. Few participants related the control labeled "Torque" to increasing or decreasing the altitude of the helicopter. • The second problem concerned the slider values. Few participants figured out that the magic number for level flight was 64. Anything less than 64, and the helicopter would loose altitude. Anything more than 64, and the helicopter would gain altitude. The magic number 64 was not obvious to the participants, and this caused some frustration in their attempts to maneuver the helicopter.	• Label the **Torque** control something more obvious like **Lift**. *A later build of the program added "Vertical Thrust" to the control's label, which is a step in the right direction.* • Use slider values that clearly indicate the value of lift, such as, negative numbers for negative lift, zero for level flight, and positive numbers for positive lift.

Tank Control Panel	
Issues	**Recommendations**
Forward and Reverse Buttons The control panel provides no feedback as to what gear the tank is in. Participants became disoriented when attempting to drive forward when they were actually driving backwards. Participants forgot what gear the tank was in. Visual cues in the VRML viewer are limited to distant terrain features and provide little immediate feedback as to the direction of travel.	Feedback concerning the direction of travel can be improved as follows: • Use radio buttons instead of push buttons, or somehow otherwise provide a visible indicator on the control panel that indicates the tank's current gear selection • Add more terrain features, such as, trees, roads, rivers, and built-up areas in the VRML viewer to help with navigation. *Navigation is discussed further below under **General Issues**.*
Firing the Gun • Participants were unable to aim the gun accurately, since no aiming aids are provided by the system. • Participants found it difficult to assess their aim using Kentucky windage, since no feedback is provided by the system concerning round impact. • Participants were unable to destroy other vehicles, even at close range. This led to dissatisfaction with the game. Participants seemed to really want to	• Provide an aiming aid, such as a reticule or a "gunner's view" that includes an aiming reticule. • Show where the rounds are impacting. Rounds impacting into the ground should kick up dust, and rounds hitting the target should create sparks. • Visual and audio feedback that indicates being fired upon or being hit should also be considered in the design of the system. *Audio is discussed further below under **General Issues**.*

blow things up and destroy other vehicles.	
Turret Orientation The system provides no feedback concerning the orientation of the turret relative to the hull. In the physical world, the tank commander can check the orientation of the turret via a bezel ring inside the turret, or by looking outside the turret to check the orientation visually.	• Place a visual indicator on the control panel • Add more terrain features to the VRML world, such as, trees, roads, rivers, and built-up areas
Turret Left/Right and Raise/Lower Gun Buttons Here is a case where the button first does what is says it does and then does the exact opposite. For example, pressing the **Raise Gun** button causes the gun tube to begin to raise. The gun will continue to rise until the user presses the **Raise Gun** button again; thus, the **Raise Gun** button implicitly becomes a "stop raising the gun" button without any visible cue to the user that its functionality has changed. The **Turret Left** and **Turret Right** buttons cause the turret to begin rotating, but the buttons must be pressed again to stop the rotation. Participants were very confused and frustrated by the behavior of these buttons.	• A more appropriate input device, such as, a joystick or the arrow keys on the keyboard should be considered in the design and implementation. *Input devices are discussed further below under* ***General Issues ® Overall GUI Design****.* • If the buttons on the control panel must be used, then their visible appearance should change when their function changes. For example, the **Raise Gun** button could flash red and its label changed to "Stop Raising Gun" whenever it is activated.
Brakes Button	• Eliminate any unnecessary buttons from

This button is not needed, since the speed of the tank may be reduced by the **Speed Control** slider control. The meaning of the button is also unclear. Braking usually means slowing a vehicle only while applying the brakes. Once the brakes are released, the vehicle is no longer braking. In the game, however, the **Brakes** button actually stops the tank immediately. *The issue here is really about the design and implementation of the vehicle control panel in general. The issue is discussed in more detail below under **General Issues -> Vehicle Control Panel Design**.*	the control panel • Redesign the control panel. See recommendations below under **General Issues**.

General Issues	
Issues	**Recommendations**
Vehicle Control Panel Design The look-and-feel of the helicopter and tank control panels suggest that their design was driven by the Java language rather than by a coherent design process. • First, both panels look almost identical. This suggests that driving a tank is almost the same as driving a helicopter.	• Redesign the vehicle control panels, so that the panels are consistent with the type of vehicle they control. The helicopter control panel should look like a helicopter control panel, and the tank control panel should look like a tank control panel. • The vehicle control panels combine controls and indicators, which is inconsistent with the real world. In the real

When, in reality, someone probably designed one panel based upon the code of the other panel (code re-use/cut-and-paste). • Second, the panels contain some unnecessary buttons, which seem to be there just to make the panel coding easier in Java (It is much easier to arrange eight buttons in Java than seven buttons). • Third, the panels make use of standard Java components only, like buttons, sliders, labels, and text fields. These components are used even if the component may not be the most appropriate metaphor for the control.	world, controls and indicators are usually separated. Controls are usually switches, buttons, pedals, gears, and wheels. Indicators are usually lights, gauges, and LED displays. Often, the only control devices and associated indicators that are usually co-located are switches and their respective indicator lights. Therefore, we recommend that separating the controls from the indicators should be considered in the design and implementation. • Other input devices may be better suited for certain actions, which are currently controlled by components on the control panel. Using control devices other than the mouse will allow controls to be removed from the control panel; thus, uncluttering the control panel and making it more of an indicator panel. *This is discussed further below under* ***Overall GUI Design****.* • If the control panels are to remain, then the recommendations suggested in the above sections (Tank Control Panel and Helicopter Control Panel) should be considered, in order to make the control panels easier to use. Grouping controls and indicators by function on the control panel would also help. For example, the controls and indicators for weapons should be visibly separated from the direction and speed controls and indicators by a vertical line or by a border around the controls and indicators. • Get rid of the big unknown square panel in

	the middle of the control panels. It did not really bother many participants, and it helps to unclutter the control panel. But no one knows why it is there or what it does. If it stays, then make it do something useful.
Collaboration The system provides no tools for collaborating with other team members. Users are left with their own imagination and innovation for creating ways to communicate with team members.	Collaboration tools that support distributed networked games should be considered in the design and implementation. Tools that were recommended by the participants included: • chat window • vehicle coloring or vehicle identification markings (bumper numbers, flags, combat vehicle icons, etc.) • white board
Software Crashes Lack of quality control in the design and implementation of the software system is made apparent by the frequency of system crashes that occurred while conducting the study. Most crashes occurred during normal use, and were often related to a control being manipulated on the vehicle control panel. This led to dissatisfaction and frustration for many of the participants. Many participants changed their behavior after a crash by being more cautious in pushing buttons and moving sliders on the control panels.	The select-delay-react behavior of the Java Swing components suggests that multi-threading either has not been implemented or has been implemented incorrectly. A careful review of the code should be conducted to check for improper use of thread methods and dangerous deprecated thread methods. This is further complicated by the fact that Java Swing components are single-threaded. The review must also check that threads are properly implemented using Swing components.

New Vehicle Button • Participants were surprised when their vehicle exploded when they pushed this button. • The button does not control the vehicle, but rather it controls the game. Therefore, it is incongruous to place this component on the vehicle control panels. *Recommendations for this particular issue is discussed below under* ***Overall GUI Design****.*	• Open a confirmation box when the user selects the New Vehicle button. The confirmation box can also explain the reason why the vehicle explodes.
Home Button The **Home** button magically transports a vehicle back to its starting position. The reason for having this capability in the game is not clear, but our participants did find the button to be useful -- for all the wrong reasons. Participants used the Home button because the system provides too few navigational aids. Whenever a participant became hopelessly lost, which was quite often, the **Home** button was a convenient way to get back to a known location.	• Remove the **Home** button from the game. *Further recommendations for this particular issue are discussed below under* ***Navigation.***
Navigation Navigational aids in the game are limited to terrain features and heading indicators on both vehicle control panels. Most participants found navigation to be very difficult. Many	• Add a map to the display that, at a minimum, shows the user's vehicle and the two home bases. • Enrich the VRML world with more terrain features, such as, trees, roads, rivers,

participants became lost shortly after starting the game and needed help finding the opponent's home base. Some of the participants who had no experience in naval operations did not understand how to use the **Heading** indicator. These participants were army officers, and they found terms like azimuth, compass direction, and the cardinal directions (N, S, W, E) more familiar and understandable.	depressions, hills, and built-up areas. • Use terms that are more familiar to a wider audience, such as the cardinal compass directions: North, South, East, and West.
Audio The system does not use audio in its interface, except to indicate that a weapon has fired. No audio cues are used to indicate that the vehicle is moving, that a vehicle is travelling nearby, that a helicopter is in the area, or that a vehicle (particularly your own) is being fired upon or hit.	Include the following audio outputs as feedback to the user: • vehicle idle, vehicle accelerating, vehicle travelling, vehicle decelerating • vehicle passing nearby • round impact on and around the vehicle
Overall GUI Design <u>Fragmented Presentation</u> The VRML viewer, the selection panels, and the control panels are not obviously related to one another. They are disjointed and appear to run independently of one another. This fragmentation of the GUI detracts from the attractiveness of the game and is a clear indication of the incomplete design and implementation of the software system.	• A single coherent GUI must be used. The application window should include both the VRML viewer and the vehicle control/indicator panel. • Additional user input devices must be implemented. For example: • Vehicle turning and weapons operation should be controlled by a joystick

Running the game requires starting four separate, but interconnected, programs. This is not the problem, though. The problem is that this fragmentation is not hidden from the user. In fact, it appears to the user that at least two separate, but not necessarily interconnected, programs are running - the VRML viewer and the vehicle control panel. A fragmented and disjointed GUI is not what the user expects to see, and this leads to dissatisfaction with the system.

Limited Input Device

All interaction and actions with the GUI are controlled via the mouse. The program is written this way because it is easier to program the interface this way in the Java language. However, Java does provide APIs for keyboard and serial port input devices. Forcing all actions to the mouse results in the following problems:

- Cluttered control panels. All controls and indicators must be represented on the screen as buttons, sliders, and text fields.
- Inappropriate metaphors for some actions, such as turning a vehicle by pushing a button.
- Executing parallel actions are difficult to perform. For example: Increase altitude, bank right, decrease speed, and fire the weapon simultaneously.

and/or by arrow keys on the keyboard.

  - Speed should be controlled by slider bars (on-screen or on-joystick) and/or numbers on the keyboard.

- Move game controlling components off of the vehicle control panels. Actions that affect the game should be placed in a menu that groups all game-controlling actions together. Game-controlling actions could include: Start Game, New Game, Change Vehicles, Network Settings, Controller Settings, Save Game, Exit, Help, etc.

Cluttered panels and inappropriate control components give the user a negative impression of the program and leads to dissatisfaction with the game. Game Controls vs. Vehicle Controls Actions that affect the game should be separated from actions that control the vehicle. The vehicle control panels include the **New Vehicle** button, which destroys the player's current vehicle and opens the **Vehicle Selection Panel**. Its placement on the vehicle control panels is incongruent with the panels' purpose, which is to control the vehicle. It is almost as incongruent as offering the **Turn Right** action as a command on a menu that includes File, New, Open, Close, Exit.	

Conclusions

In general, participants found several aspects of the Capture the Flag program to be frustrating and dissatisfying. The game, capture the flag, was not the problem; but rather it was the GUI components and software crashes that caused the dissatisfaction. The goal of this study is to recommend ways to improve the usability, and we have recommended several improvements in the above section based upon the results of the study. Several areas, however, deserve special emphasis. For our conclusions, we have chosen to comment on the areas that adversely affected user satisfaction the most. Recommendations for improving these areas are included in the above Recommendations section.

Navigation

First-time users invariably were unable to find the opponent's home base without help from the observer. Participants verbally and physically expressed displeasure while searching for the opponent's home base. The addition of a map utility and a more robust set of terrain features would aid the user in this task.

Collaboration

Without the ability to collaborate, the Capture the Flag game is not a team sport. The game is described as a multi-team networked simulation, and the program technically functions as such. However, without collaboration tools the benefit of being a team game is lost. Participants described the game as an all-against-all type of game. Participants did not care who their team members were, since there was no way to collaborate to them in a simple integrated way. Team sports inherently require collaboration for planning strategy and coordinating activities. Adding a chat capability to the system would probably be the best improvement that can be feasibly be added. Other improvements include adding a whiteboard and enhancing vehicle identification.

Visual and Audio Feedback and Cues

The system provides little feedback to the user. The lack of feedback creates the following problems, all of which, lead to user dissatisfaction:

- buttons change function without the user knowing
- vehicles easily get lost on the battlefield
- destroying another vehicle is very difficult
- tank players become disoriented
- capturing the flag is very difficult

Recommendations for improving the visual and audio feedback and cues are discussed in the section **Recommendations** above.

Software Crashes

Software crashes occurred frequently and were the greatest cause of user dissatisfaction with the system. The crashes occurred during normal operation, which lowered the participants' opinion of the system. Better design, coding, and quality assurance would eliminate this problem.

Appendix A: Task Lists

Participant's Task List

1. Select a team and proceed.
2. Select a tank and start the game.
3. Change the viewpoint to your tank.
4. Increase the speed of tank to 20 mph.
5. Change the heading of the tank to 120.
6. Stop the tank.
7. Proceed the tank in the reverse direction with 10 mph.
8. Take your tank to the game starting position.
9. Increase the elevation of the main gun to 30 degrees.
10. Decrease the elevation of the main gun to –5 degrees.
11. Rotate the main gun to the right about 90 degrees.
12. Rotate the main gun to the left to its original position.
13. Fire the main gun.
14. Fire the auxiliary gun.
15. Switch to the other team.
16. Select a helicopter.
17. Change the viewpoint to your helicopter.
18. Change the altitude of the helicopter to 200 ft.
19. Speed up the helicopter to 30 Mph.
20. Take a right turn and change your heading to 150.
21. Take a left turn and change your heading to 350.
22. Take the helicopter to the hover position.
23. Take the helicopter to the game starting position.
24. Fire the helicopter rocket.
25. Change the viewpoint to the cockpit.
26. Select a new tank.
27. Fire the main gun of the tank to a heading of 120 and elevation of 20.
28. Select a new helicopter.
29. Fire the rocket of the helicopter from an altitude of 200 ft to a heading of 270.
30. Destroy a stationary tank with a rocket.
31. Pick up the flag using the helicopter.

32. Select a new tank.
33. Destroy a stationary tank with the main gun.
34. Pick up the flag using a tank.

Evaluator's Task List

Benchmark1 (Measure performance time)

A. Select a team and proceed to the Vehicle Selection panel.

Benchmark2 (Measure performance time)

B. Select a tank and start the game.

Benchmark3 (Count the number of errors)

C. Change the viewpoint to your tank.

Benchmark4 (Measure performance time)

D. Increase the speed of the tank to 20 Mph.

Benchmark5 (Measure performance time)

E. Change the heading of the tank to 120.

Benchmark6 (Measure performance time)

F. Stop the tank.

Benchmark7 (Measure performance time)

G. Proceed the tank to the reverse direction with 10 Mph.

Benchmark8 (Measure performance time)

H. Take your tank to the game starting position.

Benchmark9 (Measure performance time)

I. Increase the elevation of the main gun to 30 degrees.

Benchmark10 (Measure performance time)

J. Decrease the elevation of the main gun to -5 degrees.

Benchmark11 (Measure performance time)

K. Rotate the main gun to the right about 90 degrees.

Benchmark12 (Measure performance time)

K. Rotate the main gun to the left to its original position.

Benchmark13 (Measure performance time)

L. Fire the main gun.

Benchmark14 (Measure performance time)

M. Fire the auxiliary gun.

Benchmark15 (Measure performance time)

N. Switch to the other team.

Benchmark16 (Measure performance time)

O. Select a helicopter.

Benchmark17 (Measure performance time)

P. Change the viewpoint to your helicopter.

Benchmark18 (Measure performance time)

Q. Change the altitude of the helicopter to 200 ft.

Benchmark19 (Measure performance time)

R. Speed up the helicopter to 30 Mph.

Benchmark20 (Measure performance time)

S. Take a right turn and change your heading to 150.

Benchmark21 (Measure performance time)

T. Take a left turn and change your heading to 350.

Benchmark22 (Measure performance time)

T. Take the helicopter to hover position.

Benchmark23 (Measure performance time)

U. Take the helicopter to game starting position.

Benchmark24 (Measure performance time)

V. Fire the helicopter rocket.

Benchmark25 (Measure performance time)

W. Change the viewpoint to cockpit.

Intervening nonbenchmark task

X. Select a new tank.

Benchmark26 (Measure performance time)

Y. Fire the main gun of the tank to a heading of 120 and elevation of 20.

Intervening nonbenchmark task

Z. Select a new helicopter.

Benchmark27 (Measure performance time)

AA. Fire the rocket of the helicopter from an altitude of 200 ft to a heading of 270.

Benchmark28 (Measure performance time)

AB. Destroy the stationary tank with a rocket from the helicopter.

Benchmark29 (Measure performance time)

AC. Pick up the flag using the helicopter.

Intervening nonbenchmark task

AD. Select a new tank.

Benchmark30 (Measure performance time)

AE. Destroy a stationary tank with the main gun.

Benchmark31 (Measure performance time)

AF. Pick up the flag using the tank.

Appendix B: Consent Form

Contact Information: This study is being conducted by a group of students participating in CS 4203. The group leader is Rusl Flowers, who can be reached via telephone at (831) 393-2312, or via email at flowers@cs.nps.navy.mil.

Risks of being in the study: This study has no unordinary risks beyond those encountered in your everyday workplace.

Confidentiality: The records of this study will be kept private. We will not make any information publicly accessible that might make it possible to identify you as a participant.

Voluntary nature of the study: If you decide to participate, you are free to withdraw at any time without prejudice.

You will be given a copy of this form for your records.

Statement of consent: I have read the above information. I have asked questions and have had my questions answered. I consent to participate in the study.

Signature: _____ Date: _____

Investigator

Signature: _____ Date: _____

Appendix C: Debriefing

Capture the Flag Usability Study

The study you have just completed is concerned with understanding how to develop the user interface for the Capture the Flag program, as well as, helping students taking CS 4203 to better understand human computer interface principles.

The tasks and the questionnaires you completed will help us to recommend ways to improve the human computer interface of the Capture the Flag program. This study is also a group project, which is required for CS 4203. The data we have collected from you and others will be analyzed, and we will make recommendations to Dr. Don Brutzman on how to improve the interface.

If you have any questions about this study, please ask the researcher or group leader. Thank you for participating in this study and for doing your best completing the tasks and the questionnaires.

Group leader: Rusl Flowers, (831) 393-2312, flowers@cs.nps.navy.mil

If you are interested in learning more about this research area, we recommend that you take CS 4203 or read the required text, Developing User Interfaces by Deborah Hix and H. Rex Hartson.

Appendix D: Research Summary Sheet

Title of Research : Capture the Flag Usability Study
Principal Investigator : Yuksel Can, Mustafa Altinkaya

Instructions: List all participants who signed consent forms regardless of whether they were actually tested or not. List the date (and length of time) of all testing. List in the notes section (with note numbers) any unusual events that occurred during testing. Use additional pages if necessary.

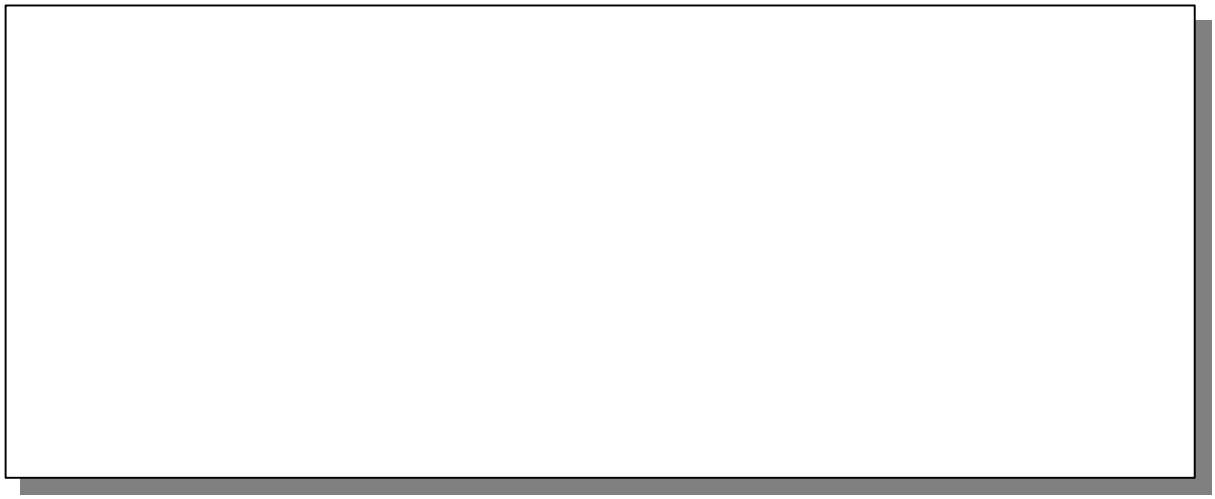
Participant's Name	Date of Consent	Date/Length of Test	Note Number

Notes:

Appendix E: Questionnaires

Pre - Questionnaire

1. What is your first impression of Team Selection panel?



2. What is your first impression of Vehicle Selection Panel?

3. What does the Multicast Address Text Field in the Vehicle Selection Panel represent to you?

4. What does the Port Number in the Vehicle Selection Panel represent to you?

5. What does the Site ID in the Vehicle Selection Panel represent to you?

6. What does the Application ID in the Vehicle Selection Panel represent to you?

7. What does the Player Identification in the Vehicle Selection Panel represent to you?

8. What is your first impression of the Vehicle Control Panel?

9. What does the left area of the Vehicle Control Panel represent to you?

10. What does the middle area of the Control Panel represent to you?

11. What does the right area of the control panel represent to you?

12. What is your first impression of the VRML Display?

Post - Task Questionnaire

1. How easy / difficult was to select a team and start the game?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

2. How easy / difficult was it to pick a vehicle?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

3. How easy / difficult was it to decide the type of the vehicle from its name?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

4. How easy / difficult was it to change the viewpoint to your tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

5. How easy / difficult was it to increase the speed of the tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

6. How easy / difficult was it to change the heading of the tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

7. How easy / difficult was it to stop the tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

8. How easy / difficult was it to proceed the tank in the reverse direction?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

9. How easy / difficult was it to take the tank to the game starting position?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

10. How easy / difficult was it to increase the elevation of the main gun?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

11. How easy / difficult was it to rotate the main gun?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy                somewhat                  somewhat           difficult
                      easy                    difficult
```

Comments: _____

What might have made this task easier?

12. How easy / difficult was it to fire the guns?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy                somewhat                  somewhat           difficult
                      easy                    difficult
```

Comments: _____

What might have made this task easier?

13. How easy / difficult was it to change the altitude of the helicopter?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

14. How easy / difficult was it to speed up the helicopter?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

15. How easy / difficult was it to change the heading of the helicopter?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

16. How easy / difficult was it to take the helicopter to the hover position?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

17. How easy / difficult was it to fire the helicopter rocket?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

18. How easy / difficult was it to aim at a stationary target from a helicopter?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

19. How easy / difficult was it to pick up the flag using a helicopter?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

20. How easy / difficult was it to aim at a stationary target from a tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat           difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

21. How easy / difficult was it to pick up the flag using a tank?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy               somewhat                  somewhat          difficult
                     easy                    difficult
```

Comments: _____

What might have made this task easier?

Post - Test Questionnaire

1. Was the layout of the control panel confusing?

YES / NO

If YES Why , How can it be improved?

2. Did the military jargon used in the panels make sense?

YES / NO

If NO , What is your suggestions ?

3. Are the input devices appropriate to control the vehicles?

YES / NO

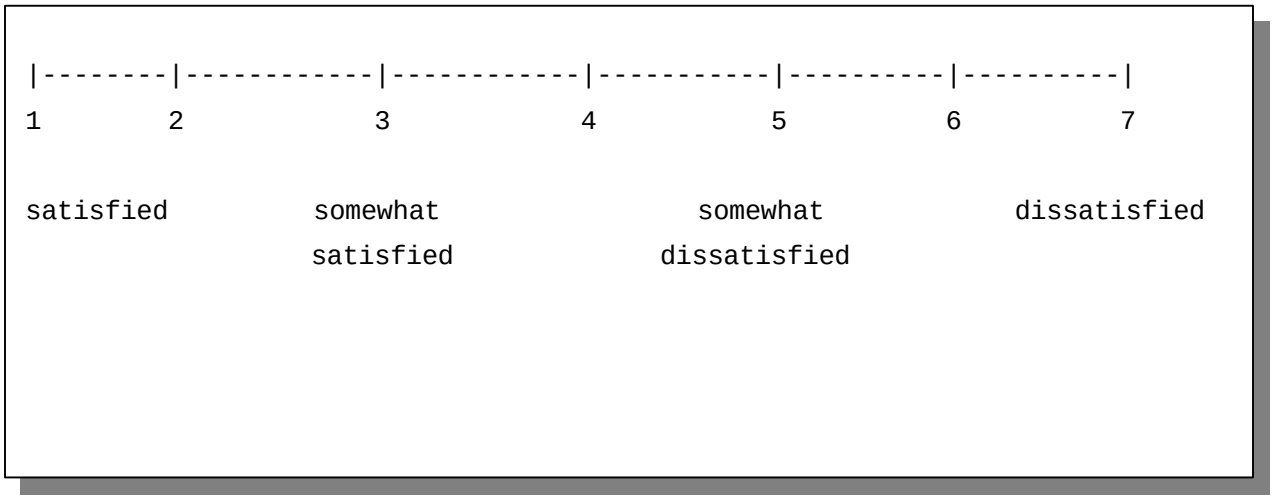
If NO Why , How can it be improved?

4. How well does the game environment reflect the battlefield situation?

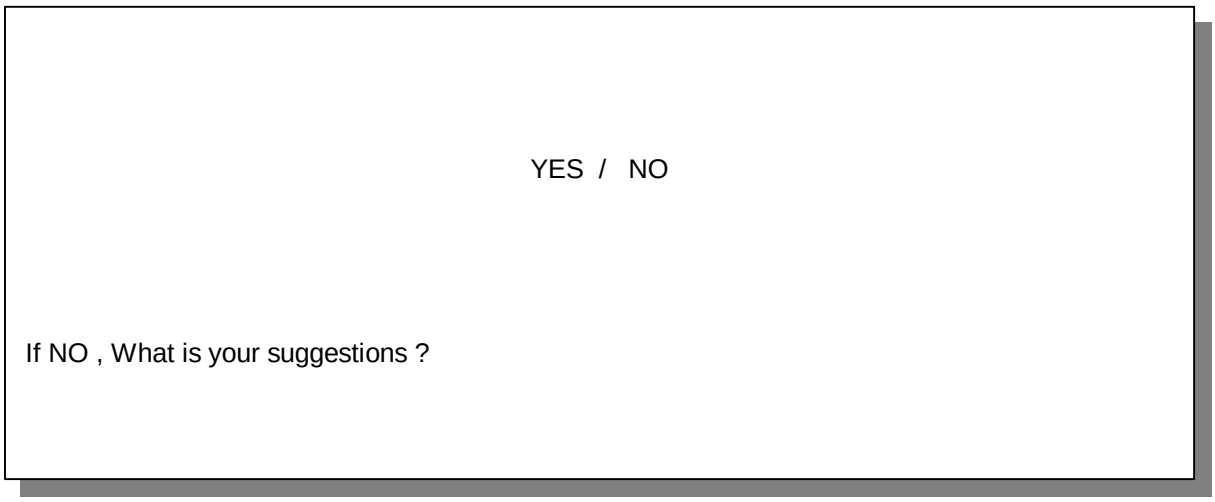
```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7

satisfied          somewhat                 somewhat             dissatisfied
                   satisfied              dissatisfied
```

5. How well do the control panels interact with the display?



6. Did the functionality of each control element reflect what you had expected?



7. How easy/difficult were the rules of the game to understand?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy                somewhat                  somewhat           difficult
                      easy                    difficult
```

Comments: _____

What might have made this easier?

8. How easy/difficult was to play the game?

```
|--------|------------|------------|-----------|----------|----------|
1        2            3            4           5          6          7
easy                somewhat                  somewhat           difficult
                      easy                    difficult
```

Comments: _____

What might have made this easier?

Appendix F: Usability Specifications Table

SPEC NO	USABILITY ATTRIBUTE	MEASURING INSTRUMENT	VALUE TO BE MEASURED	CURRENT LEVEL	WORST ACCEPTABLE LEVEL	PLANNED TARGET LEVEL	BEST POSSIBLE LEVEL	OBSERVED RESULT
1	Initial Performance	Selecting a team and proceeding to "Vehicle Selection Panel" on the first trial	Length of time for proceeding to "Vehicle Selection Panel"	NA	5 Sec	3 Sec	2 Sec	
2	Initial Performance	Selecting a vehicle and proceeding to "Vehicle Control Panel" on the first trial	Length of time for proceeding to "Vehicle Control Panel"	NA	6 Sec	4 Sec	2 Sec	
3	Initial Performance	Changing the viewpoint to the vehicle on the first trial	Number of errors on the first trial	NA	5 Errors	2 Errors	0 Error	
4	Initial Performance	Changing the speed of the tank to a given speed	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
5	Initial Performance	Changing the heading of the tank to a given course	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
6	Initial Performance	Stopping the tank	Length of time on the first trial	NA	4 Sec	2 Sec	1 Sec	

7	Initial Performance	Proceeding the tank in the reverse direction with a given speed	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
8	Initial Performance	Taking the tank to the starting position	Length of time on the first trial	NA	5 Sec	3 Sec	1 Sec	
9	Initial Performance	Increasing the elevation of the main gun to the given elevation	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	
10	Initial Performance	Decreasing the elevation of the main gun to the given elevation	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	
11	Initial Performance	Rotating the main gun to the right	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	
12	Initial Performance	Rotating the main gun to the left	Length of time on the first trial	NA	7 Sec	5 Sec	3 Sec	
13	Initial Performance	Firing the main gun	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	
14	Initial Performance	Firing the auxiliary gun	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	

15	Learnability	Selecting a team and proceeding to “Vehicle Selection Panel”	Length of time for proceeding to “Vehicle Selection Panel”	NA	4 Sec	2 Sec	1 Sec	
16	Learnability	Selecting a helicopter	Length of time	NA	4 Sec	2 Sec	1 Sec	
17	Learnability	Changing the viewpoint to the vehicle	Length of time	NA	4 Sec	2 Sec	1 Sec	
18	Initial Performance	Changing the altitude of the helicopter	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
19	Initial Performance	Speeding up the helicopter	Length of time on the first trial	NA	6 Sec	4 Sec	2 Sec	
20	Initial Performance	Turning the helicopter to the right	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
21	Initial Performance	Turning the helicopter to the left	Length of time on the first trial	NA	8 Sec	4 Sec	2 Sec	
22	Initial Performance	Taking the hover position	Length of time on the first trial	NA	3 Sec	2 Sec	1 Sec	

23	Learnability	Having the helicopter to the starting position	Length of time on the first trial	NA	5 Sec	3 Sec	1 Sec	
24	Initial Performance	Firing the rocket of the helo	Length of the time to find the fire button	NA	4 Sec	2 Sec	1 Sec	
25	Initial Performance	Changing viewpoint to Cockpit	Number of errors	NA	3 Error	0 Error	0 Sec	
26	Learnability	Firing the main gun of the tank to a given direction and elevation	Length of the time	NA	10 Sec	7 Sec	4 Sec	
27	Learnability	Firing the rocket of the helo from a given altitude to a given direction	Length of the time	NA	10 Sec	7 Sec	4 Sec	
28	Learnability	Destroying a stationary tank with a rocket fired from a helicopter	Length of the time	NA	10 Sec	7 Sec	4 Sec	
29	Initial Performance	Picking up the flag using a helicopter	Length of the time	NA	10 Sec	7 Sec	4 Sec	
30	Learnability	Destroying a stationary tank with the main gun of the tank	Length of the time	NA	10 Sec	7 Sec	4 Sec	

31	Initial Performance	Picking up the flag using a tank	Length of the time	NA	10 Sec	7 Sec	4 Sec	

Appendix G: Examination Procedure

Legend:
Procedural tasks: plain text
Verbal instructions: **"bold quotations"**

1. Before the participant arrives: The evaluator sets up the game, so that the VRML world is opened, the referee application is running, the demo.helicopter.StartPanel applet is running, and the team selection panel is opened.

2. When the participant arrives: Verbally give the following introduction about the game:

"The Capture the Flag Game was developed by students at NPS as part of on-going research in networked virtual reality military simulations. The game is structured around the familiar 'capture the flag' game, where two opposing teams attempt to steal the opponent's flag and return the flag to their own home base. The two teams in this game are the red team and the blue team. Each team consists of three helicopters and three tanks. During this game, you will control a tank and then a helicopter of one of the teams. Your teammates may be remote users from any computer system in the world that has access to the public Internet."

"Our goal is to evaluate the user interface, rather than your computer skills. Before conducting the evaluation, I will ask you to read and sign a consent form. The consent form explains that the records of this study will be kept private and that we will not make any information publicly accessible that might make it possible to identify you as a participant."

"You will be asked to answer several questions during the evaluation. You will be asked these questions before the evaluation, during the evaluation immediately after completing a task, and after the evaluation. Again, your answers to these questions will not be linked to you personally in any way. You will be assigned a number for tracking purposes only. The only document that will have your name on it is the consent form. Please do not

hesitate to ask me any questions if you are confused by the wording of a task or question."

3. Hand the consent form to the participant. Give a brief explanation about the consent form:

"Please read the consent form and sign and date. The purpose of the consent form is to ensure that you understand who to contact concerning this evaluation, the risks involved, confidentiality, and to document that you were not forced to conduct this evaluation against your will."

4. The participant reads and signs the consent form. The evaluator signs the consent form.

5. Enter the participant's information on the "Research Summary Sheet," and assign the participant a unique number. Write this number on the three questionnaires, then explain the following to the participant:

"I am assigning you a number that will be written on your questionnaires. This is to help us to track the results of this evaluation. In no way is your name associated with this number."

5. Hand the "Participant's Task List," the "Pre-Questionnaire," and the "Post-Task Questionnaire" to the participant.

6. Provide instructions to the participant for completing task 1 and 2 and completing the Pre-Questionnaire prior to continuing with the rest of the tasks:

"I have handed you three things: The first is a task list. These will be the tasks that you will complete as part of this evaluation. The second is called a pre-questionnaire. You'll answer these questions before you actually start to play the game. The third item is called a post-task questionnaire. After you complete a task on the list, you will need to answer a question concerning the task you just completed."

"I will walk you through the first two tasks and ask you to answer the questions on the pre-questionnaire and post-task questionnaire. Then, after answering any questions you may have, I will explain the rest of the evaluation to you and we can continue from there."

"Do you have any questions right now?"

7. Answer any questions the participant may have before continuing with the evaluation. After answering all questions, continue with tasks 1 and 2, the associated post-task questions, and the pre-questionnaire as follows:

"Before continuing, let me explain a little about what you see on the screen right now. The window you see here is what is called the "VRML" world. It is the virtual world, in which you will play the game. The panel here in the middle is the team selection panel. You will use this panel for the first task and for the first question of the pre-questionnaire."

"If you have no questions, we can start with question number one of the pre-questionnaire. Please read the question and answer appropriately."

8. Answer all questions and wait for the participant to complete question 1 of the pre-questionnaire.

"Before conducting each task, you will need to read aloud each task. This is to ensure that I you and I are synchronized and that I can track your progression through the task list and ask you some questions when appropriate."

"Please read task 1 on the task list aloud and then complete the task. Remember, I am only an observer. I cannot assist you in completing the task, but I can help you if you find a question or the wording of a task unclear. After completing the task, please answer question 1 of the post-task questionnaire and then wait for further instructions."

9. Ensure that the participant read the task correctly. Observe the participant complete the task and record the results in the Specifications Table. You will need to do this for each of the benchmark tasks on the Evaluator's Task List. Wait for the user to complete question 1 of the post-task questionnaire before continuing.

"Now we are ready to complete questions 2 through 7 on the pre-questionnaire. The box you see now is the vehicle selection panel. Please answer questions 2 through 7 now."

10. Ensure that the participant does not continue with the task list and that he/she answers only questions 2 - 7 of the pre-questionnaire.

"Now we can continue with task 2 of the task list. Please read the task aloud, complete the task, and then answer question 2 and question 3 on the post-task questionnaire. Once you have answered question 3, please wait for further instructions."

MAKE SURE THAT THE PARTICIPANT IS ANSWERING THE POST-TASK QUESTIONS AND NOT THE PRE-QUESTIONNAIRE QUESTIONS.

11. After the participant completes question 3 of the post-task questionnaire, instruct him/her to complete questions 8 - 12 as follows:

"Please answer questions 8 through 12 of the pre-questionnaire now. After answering question 12, please wait for further instructions."

12. After the participant finishes answering question 12, retrieve the pre-questionnaire from the participant, and instruct him/her to complete the rest of the tasks on the task list as follows:

"This concludes the pre-questionnaire. From here, you will complete the rest of tasks on the task list on your own at your own pace. Please read the task aloud, execute the task, and then answer the appropriate questions on the post-task questionnaire. Please don't hesitate to ask me a question if a task or question is unclear. When you complete all tasks on the list and all questions on the post-task questionnaire, please wait for further instructions."

13. Listen as the participant reads the task to ensure that he/she reads the task correctly. Be prepared to take measurements and record your observations for each benchmark task.

14. When the participant has completed the task list and post-task questionnaire, retrieve the task list and post-task questionnaire. Issue the participant the post-test questionnaire, and verbally issue the following instructions:

"This is the last questionnaire that you will fill out. Most questions have two-part answers. The first part will be yes/no or easy-to-difficult rating type answers. The second part will be short answer "tell us your opinion" type questions. Your opinions and suggestions are very important for this evaluation. From your input, we will suggest alternative ways to improve the user interface. Your comments can be brief and can even consist of bulletized comments. Please let me know when you have completed the post-test questionnaire."

15. After the participant completes the post-test questionnaire: 1) hand the participant a copy of the debriefing, 2) read the debriefing to the participant, 3) ask the participant if he/she has any questions, and 4) thank the participant for participating in the study.

16. Ensure that all documents are placed in their proper place. Place the consent form in the "Consent Forms" folder. Paper-clip the three questionnaires together in the following order: pre-questionnaire, post-task questionnaire, and post-test questionnaire. Place the questionnaires in the "Results" folder.

Appendix H: Result Tables

		Usability Specifications Measurements						
			Non-CS Student ID					
Task #	**1**	**2**	**3**	**5**	**8**	**9**	**MEAN**	**STD DEV**
1	1	12	2	6	2	2	4.1667	4.2151
2	3	8	6	4	3	2	4.3333	2.2509
3	5	3	4	3	2	3	3.3333	1.0328
4	6	4	1	3	1	1	2.6667	2.0656
5	2	20	40	4	8	3	12.8333	14.8649
6	1	3	1	1	1	1	1.3333	0.8165
7	5	4	3	2	2	2	3.0000	1.2649
8	31	30	8	20	11	67	27.8333	21.3861
9	4	5	2	4	14	7	6.0000	4.2426
10	5	3	2	3	3	2	3.0000	1.0954
11	3	3	4	4	2	2	3.0000	0.8944
12	2	3	2	3	2	2	2.3333	0.5164
13	1	3	4	1	1	1	1.8333	1.3292
14	1	3	1	1	1	1	1.3333	0.8165
15	30	4	5	2	17	7	10.8333	10.7595
16	1	3	1	2	1	1	1.5000	0.8367
17	1	4	4	3	1	2	2.5000	1.3784
18	52	20	7	10	9	3	16.8333	18.1264
19	1	2	1	4	2	1	1.8333	1.1690
20	3	4	4	3	10	2	4.3333	2.8752
21	1	2	1	2	2	1	1.5000	0.5477
22	1	1	1	10	1	3	2.8333	3.6009
23	2	1	1	2	3	1	1.6667	0.8165
24	1	1	1	1	1	1	1.0000	0.0000
25	1	0	3	0	5	4	2.1667	2.1370
26	10	8	5	10	10	9	8.6667	1.9664
27	12	10	7	14	8	8	9.8333	2.7142
28	19	20	20	16	18	15	18.0000	2.0976
29	39	40	20	18	19	22	26.3333	10.2892
30	10	4	15	7	11	16	10.5000	4.5935
31	8	8	20	7	10	26	13.1667	7.9099

		Usability Specifications Measurements						
			CS Student ID					
Task #	**4**	**6**	**7**	**10**	**11**	**12**	**MEAN**	**STD DEV**
1	3	4	2	1	6	2	3.0000	1.7889
2	2	2	2	2	2	2	2.0000	0.0000
3	3	10	1	8	0	3	4.1667	3.9707
4	5	2	2	2	3	2	2.6667	1.2111
5	3	7	1	6	7	1	4.1667	2.8577
6	1	2	1	1	1	1	1.1667	0.4082
7	1	1	1	2	6	2	2.1667	1.9408
8	3	1	7	1	35	10	9.5000	12.9885
9	3	3	6	4	5	7	4.6667	1.6330
10	1	1	2	5	4	3	2.6667	1.6330
11	2	2	3	2	6	3	3.0000	1.5492
12	2	3	2	3	3	2	2.5000	0.5477
13	1	2	1	4	1	1	1.6667	1.2111
14	1	1	1	2	1	1	1.1667	0.4082
15	17	40	12	15	25	2	18.5000	12.9112
16	1	2	1	2	1	1	1.3333	0.5164
17	1	2	1	3	3	2	2.0000	0.8944
18	7	6	1	5	18	17	9.0000	6.8993
19	1	1	1	2	2	2	1.5000	0.5477
20	2	1	2	2	3	2	2.0000	0.6325
21	1	1	1	1	3	2	1.5000	0.8367
22	6	1	3	1	1	1	2.1667	2.0412
23	1	1	1	1	1	1	1.0000	0.0000
24	1	1	1	1	1	1	1.0000	0.0000
25	21	1	5	0	1	1	4.8333	8.1097
26	5	5	5	6	8	10	6.5000	2.0736
27	4	6	4	8	10	9	6.8333	2.5626
28	16	8	9	8	10	16	11.1667	3.8166
29	56	8	7	30	10	21	22.0000	18.8997
30	2	8	5	10	6	8	6.5000	2.8107
31	45	4	9	7	7	7	13.1667	15.6769

Post-Task Questionnaire

Non-CS Student ID

Task #	1	2	3	5	8	9	MEAN	STD DEV
1	1	2	3	4	1	1	2.0000	1.2649
2	3	4	3	3	1	3	2.8333	0.9832
3	3	5	5	5	4	2	4.0000	1.2649
4	7	5	1	4	7	1	4.1667	2.7142
5	1	1	1	1	1	3	1.3333	0.8165
6	3	6	5	1	6	3	4.0000	2.0000
7	1	1	1	1	1	2	1.1667	0.4082
8	6	5	1	5	2	5	4.0000	2.0000
9	5	1	1	1	1	1	1.6667	1.6330
10	3	1	1	1	2	1	1.5000	0.8367
11	2	1	3	1	1	3	1.8333	0.9832
12	1	1	1	1	1	1	1.0000	0.0000
13	6	4	5	3	3	1	3.6667	1.7512
14	1	1	1	1	1	1	1.0000	0.0000
15	1	1	1	1	3	1	1.3333	0.8165
16	2	2	1	5	1	1	2.0000	1.5492
17	1	1	1	1	1	1	1.0000	0.0000
18	6	5	1	4	4	4	4.0000	1.6733
19	7	5	1	3	2	3	3.5000	2.1679
20	3	3	3	3	2	1	2.5000	0.8367
21	2	1	1	3	1	1	1.5000	0.8367

	CS Student ID							
Task #	**4**	**6**	**7**	**10**	**11**	**12**	**MEAN**	**STD DEV**
1	5	3	2	1	3	2	2.6667	1.3663
2	3	3	5	1	3	5	3.3333	1.5055
3	7	3	4	1	3	7	4.1667	2.4014
4	4	4	3	3	4	7	4.1667	1.4720
5	5	1	1	1	1	2	1.8333	1.6021
6	7	1	1	1	4	3	2.8333	2.4014
7	1	1	1	1	3	1	1.3333	0.8165
8	1	3	4	1	5	7	3.5000	2.3452
9	1	1	1	1	3	3	1.6667	1.0328
10	4	2	1	2	3	4	2.6667	1.2111
11	1	2	1	1	1	6	2.0000	2.0000
12	1	1	1	1	1	1	1.0000	0.0000
13	6	3	1	2	5	6	3.8333	2.1370
14	1	3	1	1	1	1	1.3333	0.8165
15	1	1	1	1	1	5	1.6667	1.6330
16	5	1	1	1	1	1	1.6667	1.6330
17	1	1	1	1	1	2	1.1667	0.4082
18	7	3	5	2	4	7	4.6667	2.0656
19	7	3	3	2	4	3	3.6667	1.7512
20	1	2	5	2	1	5	2.6667	1.8619
21	1	1	1	1	1	3	1.3333	0.8165

Post-Test Questionnaire

Non-CS Student ID

Question #	1	2	3	5	8	9	MEAN	STD DEV
1	1	0	0	1	1	1	0.6667	0.5164
2	1	1	1	0	0	1	0.6667	0.5164
3	1	0	1	1	0	1	0.6667	0.5164
4	3	5	3	3	4	3	3.5000	0.8367
5	3	3	3	5	5	3	3.6667	1.0328
6	0	0	1	1	1	1	0.6667	0.5164
7	1	3	3	5	3	2	2.8333	1.3292
8	6	7	5	5	5	6	5.6667	0.8165
9	6	7	6	6	5	6	6.0000	0.6325

CS Student ID

Question #	4	6	7	10	11	12	MEAN	STD DEV
1	0	1	1	0	1	1	0.6667	0.5164
2	1	1	1	1	1	0	0.8333	0.4082
3	1	1	0	1	1	1	0.8333	0.4082
4	5	2	3	3	5	5	3.8333	1.3292
5	3	3	5	2	4	3	3.3333	1.0328
6	0	0	0	0	1	1	0.3333	0.5164
7	1	2	1	1	3	1	1.5000	0.8367
8	2	3	2	3	4	6	3.3333	1.5055
9	4	4	3	4	4	6	4.1667	0.9832

Appendix I: Critical Events

The following bullets are events that the observers recorded while conducting the evaluation. These critical events were used in determining our conclusions and recommendations, in addition to the data that was collected by the questionnaires and by the Usability Specifications Table.

- After the participant clicked on the desired team button, he waits for a while for the game to start. However, when he realizes that nothing happens, he looks puzzled and tries to understand the problem. Later, he realizes that he forgot to push the start button.

- The participant had difficulty in changing the viewpoint to the selected vehicle. He thinks that he can change the view from the vehicle control panel, and he checks every button on the panel. After he realizes that he can't change the view from the control panel, he tries the buttons in the middle of VRML display and tries to change the view by clicking on the vehicle.

- When the subject is required to change the heading of the vehicle, his first reaction is to try to change the heading from the text field that displays the value of the heading. He clicks on the text field and tries to enter the new heading by using the keyboard. Following a short hesitation, he searches for another option to change the heading and finds the correct slider.

- The participant tries to drive the vehicle to the original position, when he is supposed to take the vehicle to the game starting position. At first, he never thinks that there might be a button that can bring the vehicle to the game starting position.

- When the subject wants to increase the elevation of the tanks main gun, he clicks on the "Raise Gun" button and keeps the button clicked until the main gun comes to the required elevation. He assumes that the gun will stop when the releases the button. The participant had difficulty in figuring out the functionality of the buttons, which is first click starts the action, second click stops the action.

- Firing the guns was easy for the participants and they enjoyed firing the guns and they fired several times.

- When the participant tries to give altitude to the helicopter, he first looks for a button that makes sense. He had difficulty in understanding the "torque". He is also confused with two

different altitude displays. He does not know which one should be adjusted to the required value.

- The participant waits for feedback (e.g. vehicle explosion) after he shoots at a target., and he seems disappointed when nothing happens to the target.

Appendix J: Lessons Learned

The most important lesson we learned from conducting the study is that questionnaires are not the most effective means for collecting qualitative data. Participants were not motivated to answer questions like: "What do you think would make this task easier?" Participants also did not like stopping after each task in order to answer a question. We collected very little qualitative data from the questionnaires. Most of the qualitative data came from critical events and from questions asked directly by the observer to the participant. Our methodology, however, did not formalize this requirement nor did it specify how such data would be recorded. Regardless of how we recorded or obtained the data, we did use the data in drawing our conclusions and making our recommendations. We felt that the qualitative data for this study was too valuable to ignore, despite its informal elicitation and collection. If we were to conduct this study again, we would design the methodology to facilitate more effective elicitation and collection of qualitative data.

We would videotape the session and orally ask the participant questions. We believe that this would be a more effective way to elicit qualitative information from the participants. Participants were more motivated to answer a question when asked verbally by the observer. However, participants found it easier to leave the questions blank on the questionnaires. Videotape would make the session more like a free-flowing type of session. The participant could perhaps concentrate more on the game and get more involved in the task. Video tape is better suited for recording and documenting non-verbal critical events, such as, facial expressions and breathing, than written notes by the observer. The videotape could also be re-played after the session for more in-depth analysis. The drawback to using videotape, however, could be that some participants may be uncomfortable knowing that they are being taped on video. Measures would need to be taken in order to make the participants feel more at ease, such as hiding the camera behind mirrored glass, etc.

We learned that participants were uncomfortable, even without a camera staring at them. Participants were uncomfortable with just being participants. They felt as if they were the ones being evaluated. Our methodology included assuring the participants that the purpose of the study was to evaluate the system and not the performance of the participants, but our assurance did not seem to put them at ease. Participants were critical of their own performance, and they would say comments like, "I'm not very good at this," or "I've never done this before." We also learned that it is not a good idea to run two sessions simultaneously with two different participants in the same room. The participants would evaluate their performance against the performance of the other participant. Participants became frustrated whenever they experienced an obviously

greater amount of difficulty in completing the task list than another participant. Participants seemed to make more frustrated comments about their own performance whenever they took longer finishing the session than another participant did.

References

1. Hix, Deborah., and Hartson, H. Rex., *Developing User Interfaces*, John Wiley and Sons, Inc., 1993

2. Darken, Rudy, *CS4203 Interactive Computation Systems: Course Notes*, Naval Postgraduate School, Monterey, California, 1999

3. Schmorrow, Dylan D., *A Benchmark Usability Study of the Tactical Decision Making Under Stress Decision Support System*, Master's Thesis, Naval Postgraduate School, Monterey, California, September 1998